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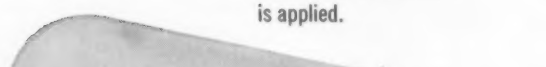

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International Scientific Action: The International Geophysical Year 1957-58

L. V. Berkner[1]

Associated Universities, Inc., New York 1

FOR the third time in a century the scientists of the world will join, during 1957–58, in a critical examination of the ever-changing aspects of man's immediate physical environment. Throughout the ages, man's curiosity about and observations of the gross manifestations of nature have provided him the elementary facts and ideas that have "hatched" into one great scientific discipline after another. The clues to nature's organization are not often related very directly to man's special sense organs. Consequently, his reconstruction of nature's processes requires the exhaustive examination of those few clues of which his senses are immediately aware, so that other phenomena, more privy to nature, may be discovered.

As Fraser (*1*) points out, for example, the external phenomena of electricity and magnetism are "sufficiently rare and unimportant in the zoological world that animals, in general, have not developed special sense organs to perceive them." The classic emergence of the science of electromagnetism, with its enormous influence on our comprehension of nature, has followed the thorough scrutiny of the implications of the simple adherence of dust to amber, the unusual behavior of lodestone, and the inspiring spectacle of lightning. The pursuit of simple clues of "Faraday, a chemist; Dufay, a botanist; Gilbert, a physician; Gray, a classicist; Franklin, a printer; Bennet, a churchman; Wesley, an evangelist; Canton, a schoolmaster; Geissler, a glassblower; Marat, a revolutionist; Morse, a painter, and so on," has led to a synthesis of the knowledge of electricity and magnetism far beyond the direct recognition of our senses. Such powerful precedents in the history of science are a challenge to man to study the clues that nature gives him, so that in comprehending them he may find new approaches to nature's organization.

Among the sciences, the discipline of geophysics has played a leading role in directing man's critical attention to new aspects of his natural surroundings. Throughout the history of science, geophysical studies and analyses have been the starting point for the growth of new sciences. Moreover, the development of geophysics has been closely allied with the evolution of our culture from superstition to comprehension; particularly so, because superstition is so often related to the gross aspects of our immediate environment. From the divining rod to modern hydrology and from the rain gods to meteorology are long steps in the process of man's civilization.

But quite apart from its honored place at the fountainheads of science and from its civilizing influence on our culture, geophysics has contributed enormously to the immediate benefit of mankind. Among innumerable examples, we may cite the multiplication of deeply buried fuel resources and minerals from precise surveys of geomagnetic and gravitational fields of the earth; or the dependence of navigation upon our knowledge of the earth's geomagnetic distribution; or the fundamental dependence of modern radio communication on our discoveries in the earth's outer atmosphere. Just within the past 3 or 4 years entirely new and vitally important modes of radio propagation have emerged as a consequence of geophysical research and resultant mathematical generalizations that have led in turn to the prediction and discovery of these otherwise unsuspected possibilities for radio propagation.

The subject matter of geophysics is necessarily broad. Geophysics includes geodesy, techtonophysics, seismology, vulcanology, hydrology, oceanography, all of which involve the physical structure and origin of the earth's crust and interior. Extending above the surface, geophysics includes meteorology, climatology and glaciology, geomagnetism and geoelectricity, and physics of the mesosphere, ionosphere, and aurora. In these latter regions of geophysical research, constant and sometimes radical change is the rule, and here the effects of extraterrestrial influence is most evident. Each of these elements of geophysics is related to others in an extraordinary number of ways: for example, meteorology to hydrology, vulcanology, and oceanography; and geomagnetism to the ionosphere, the aurora, and the physics of the earth's interior. But beyond the known relationships lie others that are suspected but remain to be established, and still others that may yet be unsuspected.

The tools of geophysics are drawn from all the natural sciences, and the discipline is synthesized by the common language of mathematics. In fact, the science of geophysics as we now know it was born with the introduction of exact mathematical means of exploring the complexities of our geoid. The forebears of geophysics were those fabulous mathematicians, Laplace, Legendre, Gauss, and Maxwell. The interaction between the natural sciences and geophysics is strong. Where astronomy and astrophysics can give clues to the source of geophysical disturbance, geophysics finds in radio noise a disturbance that is traced back

[1] Vice chairman, Special Committee on the International Geophysical Year.

to the hitherto unsuspected existence of "radio stars" and the means "to see through" the opaque arms of the galaxy. Where nuclear physics describes the interaction of cosmic rays on our atmosphere, geophysics examines their world-wide distribution to obtain clues to their origin, or discloses phenomena that reveal an unsuspected behavior of the sun. When atomic physics provides basic knowledge of the photochemical reactions of the outer atmosphere, geophysics examines these quantitatively in the superb low-pressure laboratory of the outer atmosphere that is unbounded by side walls. The forces of the universe, whether they act through electromagnetic or gravitational fields, through direct impingement of elementary particles on matter, or in other and yet unknown respects, become evident by their action on the earth's surface, its atmosphere, and its fields. As we become able to account for the character of the interaction between our surroundings and the influences upon them that act through space, we are better able to describe the nature of our extraterrestrial environment.

Curiously enough, the gross features of our natural surroundings are as yet little understood in a generalized way. When the weather "storms," we realize that the weather is fair in another place; we realize, too, that the weather at every place over the earth consists of related elements of a definable whole that changes in response to specifiable natural forces. When the aurora plays, we know that it may be playing, though somewhat differently, at another place in response to natural forces. The extension of natural phenomena in varied forms over the whole of the earth's surface makes their general description extraordinarily difficult; yet how are we to understand phenomena if we cannot describe them? Our desire to compile such a description is heightened by the educated suspicion that such a description will lead to new and vital clues to our understanding of nature and to the growth of whole new disciplines of science.

The purpose of geophysics is to provide a concise generalized description of our gross natural environment from which we can comprehend its variations from time to time and from place to place. Many aspects of this environment, such as the earth's principal surface features, change so slowly that we may travel from place to place to observe them and can synthesize our observations with the leisure of ages.

Other aspects, such as the level of the sea, or the extent of the glaciers change more appreciably. But since they remain sensibly constant over a year or a lifetime, we can make "epochal" observations to ascertain the nature of these changes over the generations. Oddly enough, man has shown little enthusiasm for establishing these "epochal bench marks" that are unlikely to produce immediate benefit to him, however important these may be to his successors. How eagerly modern scientists make use of such infrequent records as the one left by Henry Hudson, who sailed his Half Moon in the early 16th century into that great bay in Canada named after him. His journal records that he stood on the ice at the shore to mark the event on the stone of the cliff that arose out of the bay. Today that record has risen some 60 ft, indicating the rate of rise of the northern end of our continent as it recovers from the glacial loading of the Pleistocene epoch around the hinge that passes through the Great Lakes. Such simple epochal records as these are enormously important to geophysics.

Other aspects of our surroundings, such as the weather, or the ionization of the earth's atmosphere, or the strength and direction of the earth's magnetic field, or the tides of the air, the sea, and the earth's crust, change more quickly. Many such phenomena are found to vary periodically, either simply or as the complex sum of differing and superimposed periodic variations. These may be connected with the earth's rotation, or "day," its orbital motion, the relative positions of nearby astronomical bodies such as the moon and the sun, the sun's rotation on its axis and the extent of activity on its surface. Moreover, the variations of two or more of these phenomena may be directly related in the sense of cause and effect. For instance, the diurnal change of geomagnetism appears to rise from the daily variation of ionization and of the great tides in the atmosphere, produced, respectively, by direct effects of the sun's radiation and the combined gravitational forces of the sun and the moon.

Then, finally, there are quickly changing and too-often unpredictable events in our surroundings known as "disturbances" or "storms" that occur at irregular intervals. In some elements of nature, such as the weather, storms may be relatively local, and a large number may simultaneously, with ever-changing character, move rather slowly over the earth's surface. In other elements, such as geomagnetism, the onset of the storm may occur everywhere over the earth simultaneously, with varying aspects appearing in different locales as the storm develops. In still other elements, such as the aurora or the ionosphere, some storms may spread rather quickly from a region near the poles, although in such cases there remains considerable doubt concerning the morphology of auroral disturbance. Auroral curtains have been observed to move as quickly as 100 km/min over the earth's surface.

Because great storms occur at irregular intervals and are nonperiodic, they are not regularly anticipated and often have a major influence on human behavior and even existence. Great storms, because of their unusual character, provide a multitude of clues to the fundamental character of nature. But such irregular disturbances are often most difficult to describe with precision because of their unexpected and transient character, their existence beyond the view of a single observer, and their varying complexity from place to place. Moreover, even when a succession of storms is observed at one place, each disturbance may appear to differ from the others because of the intervening change in the general environment with the passage of time. Yet a generalized description of the morphology and origins of storms in nature's several elements promises to extend substan-

tially our comprehension, control, and utilization of nature's organization. The history of the progress already achieved confirms this expectation abundantly.

Obtaining a geophysical description of any natural element of our surroundings as it appears over the earth's surface, means that observations must be made at a sufficient distribution of points over the surface to permit generalization with the required precision. This process of "exploration" was known to the ancients in the development of general geography. In recent times, it has been extended to include world surveys of gravity, of the earth's general magnetism, of geodesy, of ocean features, and of climatology, among many others. The spacing of observation depends on the precision required; and in geophysical surveying for oil or minerals, where small anomalies prove of utmost importance, the survey points must be close together indeed. When the quantity to be surveyed varies in magnitude with time, then the observation at each survey-point on the surface must be repeated at time intervals that are sufficiently short to permit description of the variation at that point. When the variation is rapid, as it is during a storm, then observation must be continuous at each of a sufficient number of survey-points spread over the affected area, if we are to obtain a description of the storm. When it is spread over the earth, then the survey must be world wide. Furthermore, all measurements or observations must be referred to defined standards and procedures if the resultant description is to be generalized in a quantitative way.

Moreover, geophysics is predominantly an observational science, because the quantity to be observed is rarely under laboratory control. Therefore, the data for each station may include a complex of two or more superimposed variables whose independent status can be separated and established only by statistical treatment of a sufficiently long observational series.

The quantitative general description of a highly variable, world-wide aspect of nature is a most difficult task. The geography of the earth, with its political subdivision of nations having varying policies, makes the arrangements for simultaneous survey over the earth's surface according to prescribed standards a matter of detailed prearrangement. Full advantage must be taken of geography to obtain sufficient coverage of ocean areas, and "open" areas must be spot checked by observation from ships or aircraft to permit controlled extrapolation. The polar regions offer special problems of accessibility that require expensive expeditionary coverage. Therefore, a substantial part of geophysical progress is dependent upon intimate collaboration of the scientists of many nations. To geophysics, the world must be its laboratory.

The study of world-wide variables of geophysics, looking to their generalized description follows two general courses. First, phenomena may be studied continuously and in detail at each of a number of carefully selected stations. Over an interval of time long enough to obtain all representative variations, a phenomenon at a station can be generalized through analysis to represent its variations and to relate this representation at that station to the fluctuation of other associated geophysical elements. Moreover, time variations of phenomena between stations can be compared, to provide their generalized description over the earth. This is the basis for such great centers of geophysical activity as those near Greenwich (now Hurstmanceaux), Paris, Potsdam, Washington, Tokyo, Leningrad, Canberra, Ottawa, and the Geophysical Institute of Alaska. Furthermore, strategically located satellite stations operate out from such centers to provide simultaneous information representative of a larger area, so that a better spatial picture can be conceived. From these continuing geophysical activities, the broad outlines of the geophysical organization of nature's variables are principally derived. Unfortunately, certain key areas, such as the antarctic, are entirely devoid of very essential continuing activity of a kind that seems essential to the solution of geophysical problems.

Experience has shown that these continuing activities are far from sufficient to provide all information needed for a detailed synoptic description of the organization and behavior of particular events. What is the world-wide description of the appearance and growth of a particular auroral disturbance? Does a succession of such disturbances develop along a common pattern? Questions of this type, applying to almost every geophysical variable, lead to the second great class of geophysical observation—namely synoptic observation. Although this type of observation is applied to meteorological phenomena in limited areas of the world, it can seldom be extended to the whole world, because of cost and effort involved. Because simultaneity of synoptic observation everywhere is essential to a world-wide description of an event, geophysical scientists are strongly impelled to agree on an interval when they will all concentrate on the operation of a sufficient network of synoptic stations to obtain its universal description.

An International Geophysical Year is such an interval. An international year serves two purposes: It provides an internationally agreed upon interval of unusual geophysical activity when it is especially profitable to occupy inaccessible areas, such as the antarctic, for the purpose of supplementing the great continuing geophysical activities with observations in vital areas. And it provides opportunity for the geophysicists of the world to plan strategic networks for synoptic description of particular kinds of world-wide geophysical events, particularly meteorological, magnetic, ionospheric and auroral "storms" or disturbances whose spatial morphology and history are otherwise beyond our grasp.

Symbolic of the growth of man's civilized values, two international geophysical years have been conducted, and the third, the International Geophysical Year of 1957–58, is now being planned. With the growth in geophysics in the last century, exact information of the little-known portions of the world became imperative. Moreover, this information was

needed in synoptic form, representative of the whole area involved. As a consequence, in 1883, a joint international effort to collect such data was made; it was known as the First International Polar Year. This early and concentrated exploration of geophysical phenomena produced enormous results: It led to great clarification of our knowledge of geomagnetism and to the first orderly representation by Fritz of auroral phenomena, which described the zone of maximum auroral activity some 23° from the geomagnetic pole. A real step had been taken to destroy the old beliefs in the magic of common phenomena and to transform these to a rational scientific basis. The Second International Polar Year was held in 1932–33 on the 50th anniversary of this first great international effort. In spite of the fact that this effort coincided with a period of international economic disaster, the leadership of Dr. D. LaCour brought the program to fruition. Many advances grew out of this effort, not the least of which was the realization that the polar regions of the earth had become easily accessible for scientific observation. It was this second polar year that led directly to the conception of the Geophysical Institute of Alaska.

The interval following this second era of international cooperation in geophysics was extraordinarily fruitful in the production of the means for further geophysical exploration. With the radiosonde, meteorologists have extended their range of observation to nine-tenths of the mass of the atmosphere. The multifrequency ionospheric recorder has come into being, making possible the delineation of the principal features of the outer atmosphere; the discovery of ionospheric storms coincident with auroral and geomagnetic storms; and the discovery of "radio fade-outs," those sudden ionospheric disturbances that are coincident with solar chromospheric eruptions, with a most peculiar geomagnetic effect, and sometimes with extraordinary bursts of cosmic-ray intensity. Rockets have flown into high reaches of the atmosphere and, in conjunction with other techniques, provide measures of composition and temperature. Moreover, rockets permit us to see the sun as it appears outside the blanket of the earth's atmosphere. New radio and meteoric techniques give direct knowledge of wind motions in the high atmosphere. Views of the composition of the outer atmosphere have undergone a revolution as measurements of winds and patterns of atmospheric circulation have been disclosed. Complex apparatus discloses the existence of centers of night airglow that move. Auroral spectroscopy has disclosed the influx of protons at least at the outset of auroral disturbance, and movements of the aurora are now studied by special photographic instrumentation. And finally, the powerful tools of wave-mechanics and the electronic computer have come into widespread use in the synthesis of observed results.

This revolution in our power to observe and to synthesize has vastly extended our comprehension of the organization of nature around us. But in doing so, it has extended our perception to include new phenomena and has whetted our curiosity to have the descriptions of both old and new phenomena on a world scale. Against such a background has the world organization of science arrayed itself for the solution of these problems.

Meeting at Brussels in 1950, the Mixed Commission on Ionosphere recommended to its sponsoring unions that a Third International Year be held in 1957–58 to coincide with the eminent peak of the solar cycle and the 25th anniversary of the Second International Polar Year. After 1957–58, it is anticipated that geophysical disturbance will not again be as frequent until about 1970. The idea caught on quickly, and these unions recommended to the International Council of Scientific Unions that an International Geophysical Year (IGY), or Année Geophysique Internationale (AGI) be internationally sponsored. Substitution of the words *geophysical year* for *polar year* reflects recognition of the need for world-wide synoptic observation and analysis.

The International Council of Scientific Unions has appointed a Special (International) Committee on the International Geophysical Year, or CSAGI (Comité Special de l'Année Geophysique Internationale), with responsibility for planning geophysical activities and coordinating the programs of the unions and of the national committees. This committee has been organized under the presidency of the world's most distinguished geophysicist, Prof. Sydney Chapman, Queen's College, Oxford. It is composed of representatives from all the sponsoring international unions, including the International Union of Geodesy and Geophysics, the International Scientific Radio Union, the International Union of Pure and Applied Physics, the International Astronomical Union, and the International Geographical Union, together with representatives of the World Meteorological Organization. At a provisional meeting in Brussels in Oct. 1952, the CSAGI urged the formation of national committees and requested reports by the national committees and by the sponsoring unions and the WMO outlining suggested elements of the program for the IGY.

All the sponsoring unions, the Mixed Commission on the Ionosphere, and the newly organized national committees of many nations have submitted preliminary proposals. These nations include Argentina, Australia, Austria, Belgium, Brazil, Canada, Czechoslovakia, Denmark, Finland, France, Germany, Great Britain, Greece, India, Japan, Netherlands, New Zealand, Norway, Pakistan, Spain, Sweden, Switzerland, Tunisia, Union of South Africa, United States of America, and Yugoslavia. Since the time has been short, not all nations have yet submitted provisional programs, but it is reasonable to suppose that within the year world adherence will be accomplished.

The CSAGI held its first formal plenary session in Brussels June 30 through July 3, 1953. At this meeting, the CSAGI promulgated a provisional program, based on the proposals received, for the development of means for further and more exact planning by the

unions, the national committees, and other interested agencies. The CSAGI is now awaiting detailed national programs for observations, synoptic networks, and expeditionary operations, which are due from the national committees by May 1954. During the summer of 1954, particular elements of these national programs will be synthesized at meetings of the IUPAP (London, July 12); Mixed Commission on Ionosphere (Brussels, Aug. 16); URSI (The Hague, Aug. 22); IUGG (Rome, Sept. 15); and the Special and Executive Committees of WMO (September). Finally, the world program will be integrated by the CSAGI (Rome, Sept. 30–Oct. 4). An important aspect of this work throughout the summer of 1954 is the detection of defects in the program, so that these can be corrected. Thus, a volume outlining the world program for the International Geophysical Year 1957–58 should be ready for distribution early in 1955, in time for adequate advance preparation.

The organization and operations of the U.S. National Committee for the IGY is an example of the national function in the preparation of the international plan. This committee is organized by the National Academy of Sciences and reports to CSAGI through the National Research Council, which is the formal United States organization through which American science adheres to the International Council on Scientific Unions. Under the chairmanship of Prof. Joseph Kaplan, University of California at Los Angeles, it comprises leading American geophysicists, representing all related geophysical disciplines and organizations, including interested United States Government agencies, as well as academic and educational institutions. The committee responds to the requests of CSAGI by recommending the program for United States participation. Moreover, at the request of the committee, the National Science Foundation has agreed to organize and sponsor the United States participation in the program of the IGY. The committee and the Foundation are cooperating splendidly in developing United States participation.

The CSAGI has proposed for purposes of planning that programs be organized in nine general scientific areas: meteorology; latitude and longitude determinations; geomagnetism; the ionosphere; aurora and airglow; solar activity; cosmic rays; glaciology; and oceanography.

The CSAGI has designated as the world rapporteurs for each discipline, member scientists who will be ultimately responsible for the organization of the world program in that discipline. In addition, a special world committee on World Days has been named to designate specific intervals of special observation during the International Geophysical Year. Corresponding to this organization, the United States National Committee has designated member scientists as United States reporters to supervise the planning of United States participation in each discipline. These United States reporters are supported by special committees of United States national committees of sponsoring international unions to aid in the planning of programs for the disciplines in which they are involved. Thus, for example, the United States reporter on aurora and airglow is supported by the very active committee of the U.S. National Committee of the International Scientific Radio Union.

In order that the concentrated effort may be reduced to the minimum needed for adequate analysis, special intervals of observation to be known as World Days are to be designated. Three regular World Days will be specified each month, one near full moon and two near new moon. In addition, an average of two special World Days will be designated each month, about 3 weeks in advance, to coincide with predicted geophysical disturbances, solar eclipses, solar flares, and unusual meteor showers, and with special rocket launchings.

The announcement of beginnings of world-wide disturbances, designation of special World Days, and other pertinent and current information will be made over a world-wide network of radio stations. Ten consecutive days each season may be designated as Meteorological Intervals for studies of special meteorological significance. The scientific agencies responsible for prediction will be designated by CSAGI this summer.

The scientific program for the IGY is already taking form. But discussion of it here can include only a very few illustrative problems and these in the barest outline. The ultimate plan will fill a thick volume.

In the field of meteorology, the World Meteorological Organization, together with representatives of the Association of Meteorology, IUGG, has proposed a particularly comprehensive program in the study of world atmospheric circulation. Along the 10°E, 140°E and 75°W meridians from pole to pole, for example, measurements across the vertical sections of the atmosphere will be established. The objective of this program is to study the mass transfer of atmosphere in the east-west direction. Furthermore, a dynamical study of the equatorial atmosphere, which will lead for the first time to a knowledge of the mass interchange of atmosphere between the two hemispheres and of the relation of this transfer to the general circulation pattern, is proposed. The program of meteorology particularly emphasizes the study of the interdependence between the geophysical phenomena of the high atmosphere and the meteorological phenomena of the low atmosphere in relation to variations of weather and climate. The antarctic, with its 6,000,000 mi^2 at an average altitude of nearly 6000 ft, represents the coldest area of the earth, and its influence on weather and climate is little known. G. S. Simpson has suggested that pressure waves, or surges, spread outward from this area and northward across the equator to influence the weather everywhere. Expeditionary observations in the antarctic and the stations along the meridian lines will check the existence and movement of such surges. The radisonde will extend observations to nearly 30 km during Meteorological Intervals. These, together with rockets and meteoric measurements and ionospheric observations, will per-

mit studies looking toward synthesis of the relationships between circulation and behavior in the troposphere, the mesosphere, and the ionosphere.

This very brief and inadequate discussion of some aspects of the program on meteorology suggests the possibility that the IGY may disclose for the first time some of the really basic information that we need in understanding the world circulation pattern.

In the field of geomagnetism, the CSAGI considers the two major problems to be (i) the changing morphology of magnetic storms and activity, including bays and pulsations, and (ii) the daily variation of the three magnetic elements in the zone containing the magnetic and geographic equator. The program of geomagnetism not only is designed to produce information bearing on these problems, but it recognizes, also, the great need for geomagnetic information by other scientific disciplines operating during the IGY—in particular, special observations, in unusual and inaccessible areas of the earth, established to aid ionospherieists and others. Rocket observations will be extended to very high altitudes, which may show whether or not at times of intense aurora the electric currents producing geomagnetic change are localized along auroral sheets or arcs, and which may also provide more direct information on the electric currents in the atmosphere, particularly the intense flow across the polar caps.

Special attention is given to the observation of the aurora and airglow. The CSAGI recognizes the great need for synoptic information of the development of auroral displays. Does the auroral zone simply move south during magnetic activity or are the auroral displays extended southward from the normal auroral zone? What are the relationships between specific auroral phenomena at various places around the earth at times of great activity? Are there special auroral phenomena associated with periods of magnetic calm, particularly over the polar cap? Are the characteristics of the aurora in the antarctic comparable in detail with those of the arctic, or how do they differ? These are questions that require a concentration of observation by all nations during the IGY. Emphasis will be placed on the synoptic studies of the world-wide great displays. Plans are being made to permit relatively inexperienced observers located over very wide areas to make simple but significant observations, on punched cards, which can be readily synthesized by the scientists working on the program. Pilots of commercial aircraft over land and sea and officers of ships will be mobilized as observers.

In one especially exciting experiment, an attempt to identify simultaneous auroral arcs in the Northern and Southern Hemispheres will be made. In what amounts to a particle spectrometer 7000 mi long, using the earth's magnetic field as a lens, stations near both ends of a magnetic line of force will observe time coincidence and parallax of auroral arcs. Such an experiment will involve simultaneous cooperation of expeditionary stations of many nations, but it may be critical in establishing the causes and nature of auroras. Measurements using spectrometers of very high dispersion look to definition of regions where primary particles enter the atmosphere and to comparing the aurora borealis and the aurora australus. More accurate location of the southern auroral zone is anticipated. It seems probable that a really great advance in our knowledge of the origin, character, and distribution of auroral displays will be made during the IGY. This seems especially appropriate when we remember the impetus given to auroral research by the work of Fritz on the data produced 75 years ago during the First Polar Year.

During the IGY, the growth of our knowledge of airglow and the development of instrumentation needed for its observation will make possible important new corollary observations. Proposals are, therefore, under consideration for the synoptic observation of the airglow in specified areas connecting Europe and America and of the movements of intense centers of airglow with the new instrumentation now available.

The ionospheric program recognizes the need for the establishment of meridian lines for observation that coincide with those proposed for the meteorological vertical sections. The importance of recording normal incidence ($P'f$) is recognized, with hourly observations under normal circumstances, but with observations at quarter-hour intervals during the special World Days and during unusual disturbances. The CSAGI has recommended special studies devoted to the observation of ionospheric winds and tides and to the morphology of ionospheric storms. In particular, measurements of radio-wave absorption in the ionosphere by related methods will be emphasized to give the key to distribution of ionization in the D-region.

Studies of the ionosphere will be strongly supported by auxiliary rocket measurements made with relatively inexpensive high-altitude rockets designed for measurement of temperature, pressure, air motion, and spectroscopy of the sun's ultraviolet spectrum above the level of its atmospheric absorption. Attention will be given to "whistlers," that curious radio noise that appears to originate from lightning strokes in the opposite hemisphere near the opposing end of a magnetic line of force and propagated along that line far outside the atmosphere.

The effects of the various types of solar activity on geophysical phenomena during the IGY represent an important aspect of the total program. Therefore, particularly complete and continuous solar observations are proposed during the IGY. The recommendations related to publication of the results of observation of solar activity place emphasis on the observation of chromospheric flares, continuous observations of wave-frequencies involving chromospheric and coronal radiation, the photometry of the solar corona, and related solar observations. Also emphasized is the great importance of further observations, particularly by rocket measurements, of the solar ultraviolet emission spectra.

An expanded program for the observation of cosmic rays as they relate to geophysical and solar processes is planned. The thorough exploration of the primary cosmic-ray spectrum with respect to both mass and energy is planned. This spectrum will be examined, particularly with respect to latitude, in order that the range of energy of the various mass components may be ascertained. The variation of the neutron component will be recorded as a sensitive indication of variation in the incident primaries with respect to locality. In particular, it is hoped that the "ring-current" hypothesis of geomagnetic disturbance can be tested through cosmic-ray observations. Moreover, the extraordinary soft "solar component" of cosmic rays following certain chromospheric eruptions will be given special attention.

The relative locations of geographic points on two continents are not now known more accurately than a few hundred feet. With new and independent techniques employed at about 15 or 20 stations, this error can now be reduced to less than 100 ft. Therefore, tests of the ideas of continental drift and related crustal deformations can finally be tried. The program of latitudes and longitudes during the IGY will provide the first step toward the accurate and permanent connecting of the geodetic surveys of the continents. The observations will be made on the moon with the use of a new photographic technique of Markowitz, and on the stars with a prismatic astrolabe recently developed by Danjon.

Important programs of glaciology and oceanography are planned for the IGY. The oceans, covering four-fifths of the earth's surface, are closely linked to our lives as avenues of commerce, as important sources of food, and through their effects on meteorology. Glaciers are sensitive indicators of climatic change and retain a quantity of water equivalent to a depth of the order of 100 ft above sea level. Several seeming "anomalies" in seasonal change of ocean levels will be studied. Likewise, measurements to determine mass flow of the oceans are planned. Epochal bench marks will be established or checked in glacial growth and recession. In particular, the nature and extent of the "warming tendency" of the earth will be carefully checked, since at the present rate it seems that the arctic may become navigable in less than a century.

The International Geophysical Year offers a special and exciting opportunity for simultaneous and synoptic geophysical observation that may lead to significant geophysical progress. This interval offers extraordinary opportunity to expeditionary groups to contribute effectively to geophysical science through the addition of vital stations in the arctic, the antarctic, and other inaccessible regions. Scientific observation in arctic areas represents no particular difficulty; and, in view of the widespread occupation of those areas in this hemisphere by the United States, Canada, and Denmark, a widespread arctic program seems certain. The active geophysical program of the Geophysical Institute at College, Alaska, greatly enhances the arctic potentialities.

The antarctic, on the other hand, still constitutes the major geographic challenge. It is strange that in this day and age so little is known of that great continent of extremes that may so greatly influence our environment. With the powerful tools of science and logistics now available, the planned antarctic programs and expeditions should make great progress toward clearing up the scientific unknowns now associated with the area. The report, *Antarctic Research, Elements of a Coordinated Program,* (Washington, 1949), issued by the National Academy of Sciences after a special study, provides an important guide to the antarctic operations.

Perhaps the most important aspect of the IGY is the simultaneity of all the related scientific programs, which will make possible a synthesis of the results of complementary observations in related sciences. Continuous programs of geophysical observation are expensive and burdensome, but concentration on simultaneous programs during 1 year will be feasible and productive, particularly when emphasis is placed on observation during regular and special World Days. The powerful tools now available for observation in themselves insure outstanding contributions to our understanding and comprehension of the environment in which man now finds himself.

But most encouraging of all has been the genuine enthusiasm with which the scientists of the earth, and the nations that support them, have embraced the program. Tired of war and dissension, men of all nations have turned to "Mother Earth" for a common effort on which all find it easy to agree.

Reference

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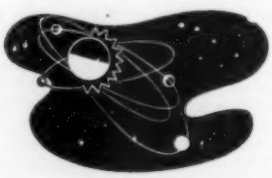

National Academy of Sciences

Abstracts of Papers Presented at the Annual Meeting
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Does Solar Variation Control Weather?

Charles G. Abbot, *Smithsonian Institution*

The author claims the discovery of a family of periodicities in solar variation comprising more than 20 members, all aliquot parts of 22¾ yr. These, he claims, control weather as concerns monthly and seasonal march. Meteorologists doubt the adequacy of the author's proof and say that, even if real, these solar variations are too small in percentage to produce important weather effects. The author shows that the family of periodicities *exists in weather.* It makes no difference how discovered, or whether solar variation is accredited or not. Forecasts of weather thereby, up to 50 yr in advance, give high coefficients of correlation.

Amino Acids in Fossils

Philip H. Abelson
Carnegie Institution of Washington

Amino acids have been discovered in association with a variety of invertebrate and vertebrate fossils. An Ordovician trilobite Calymene (approximately 360 million yr old) contained amino acids, three of which have been isolated and identified as alanine, glutamic acid, and valine. These three compounds were also found in a fossil vertebra of the Jurassic dinosaur Stegosaurus. Eight other invertebrate and four vertebrate fossils also contained identifiable amino acids.

Particular attention was devoted to $CaCO_3$ fossils. Recent shells of clams, oysters, and tropical snails had 0.1 to 0.2 percent protein made up of most of the common amino acids. Older shells had an amino acid content of 0.1 percent and less. The less stable amino acids, such as tyrosine, were notably diminished or absent in the more ancient remains.

The fossil observations have been correlated with laboratory studies of the temperature stability of amino acids. Experiments conducted at 200°–260° C on aqueous solutions and on amino acids contained in the proteins of clam shells have led to additional knowledge of the thermal stability of amino acids. Half of the alanine present in a dilute solution disappeared in 4 hr at 250° C in a process involving a first-order reaction. From this type of observation, it was estimated that, in storage at room temperature, half of any original alanine could remain after 2 billion yr.

These findings have significance for paleontology and geology.

Effects of Electroconvulsive Shock on Mating Behavior in Male Rats

Frank A. Beach, Allen Goldstein, and George Jacoby
Yale University

Male rats were observed in a series of seven standardized mating tests, during which their responses to receptive females were recorded quantitatively. Each male then received 12 daily shock treatments, which induced pronounced convulsions. Mating tests were conducted after the fourth, eighth, and twelfth shocks, and testing continued for 28 days after the final shock. Some of the measures of sexual activity changed during the period of treatment and then returned to preshock levels following recovery. A number of other behavioral indices revealed lasting increase in the capacity for mating performance.

Self-Focusing Solar Ion Stream Theory of the Aurora

W. H. Bennett and E. O. Hulburt
Naval Research Laboratory

It is assumed that the sun emits a jet of an electrically neutral mixture of fast electrons and positive ions, and that the space between the sun and earth is filled with an ionized, electrically neutral gas whose density may be as small as 1 charged particle per 10^5 cm^3 everywhere except near the sun and near planetary bodies. As the jet rises through the sun's atmosphere, the fast electrons are scattered out of the jet more rapidly than the fast positive ions are, owing to collisions with the slow particles in the sun's atmosphere. The increasing excess of fast ions over fast electrons in the jet is electrically neutralized by slow electrons that remain in the space occupied by the jet, and the excess of fast ions electrically repels slow positive ions from this space. The excess of fast positive ions over fast electrons produces an electric current with which is associated a magnetic field that magnetically repels the remaining fast electrons from the jet while magnetically attracting the fast ions toward the axis of the jet. This produces a magnetically self-focused stream [W. H. Bennett, *Phys. Rev.* 45, 890 (1934)], which consists of fast ions and slow electrons and which continually purges itself of fast electrons and slow ions. Such a stream remains focused, and if correctly aimed, enters the earth's magnetic field and is diverted to auroral latitudes on the earth according to the calculations of Störmer. Meinel's observations [*Astrophys. J.* 113, 50 (1951)] indicate that the primary solar particles in the stream are protons with speed greater than 3.10^8 cm sec^{-1} and these protons have to have a speed of the order of 10^{10} cm sec^{-1} in order to reach auroral latitudes according to Störmer's calculations. It is suggested that the auroral rays are not the solar proton stream but are formed when the protons are stopped in the upper atmosphere.

Basic Physico-Chemical Changes in Yolk and Embryo During the Course of Embryonic Development

Joseph Hall Bodine, *State University of Iowa*

A quantitative study has been made of the basic chemical composition and changes taking place in the yolk and embryo during the course of embryonic development. The cleidoic egg of the grasshopper has been employed as experimental material, since no organic connections between yolk and embryo seem to exist. Changes in sul-

fydryl, phosphates, and various enzyme systems have been investigated. It now appears that the yolk may be looked upon almost solely as a catabolic system and the developing embryo as an anabolic one. Basic differences in the two systems are found in most phases of their psysicochemical changes throughout development.

The Morphology of Ionospheric Storms

H. G. Booker, *Cornell University*

An ionospheric storm is primarily a disturbance of the F region of the ionosphere, although near the auroral zones there is also disturbance in the E and/or D regions, resulting in attenuation of HF radio waves. Except in low latitudes, an ionospheric storm involves a marked decrease in the maximum electron-density of the F_2 region and a marked increase in the virtual height of the F_2 region. Whether there is any decrease in the total number of electrons in the entire F_2 region is, however, uncertain. There is one day during an ionospheric storm (the "zero day") on which, particularly in the forenoon, the maximum electron-density in the F_2 region is decreased most markedly (perhaps to half of the normal value). After the zero day, there is a slow recovery extending over several days. As one moves from high to temperate latitudes, phenomena become less complex, and one often finds that the storm has affected the maximum electron-density of the F_2 region for 1 or 2 days prior to zero day. This effect consists of a moderate increase in the maximum electron-density of the layer. In temperate latitudes, therefore, there is often a "positive phase" to the storm in which the maximum electron-density of the F_2 region is increased somewhat followed by the main "negative phase," in which the maximum electron-density of the F_2 region is reduced. As the equator is approached, the negative phase decreases in importance and the positive phase increases. At the magnetic equator, there is only a positive phase, which, however, occurs on roughly the days of negative phase at high latitudes.

In high latitudes, there is a close relationship between the occurrence of ionospheric storms and the occurrence of magnetic and auroral disturbances. Ionospheric storms are most frequent and more intense at sunspot maximum than they are at sunspot minimum. Ionospheric storms are more frequent and more intense at the equinoxes than they are at the solstices; in winter, ionospheric storms are comparatively rare.

Diurnal variation is apparent in the manifestations of ionospheric storms. In particular, F-region echoes obtained on an ionospheric sounder at night during ionospheric storms are quite blurred and have a high fading rate, whereas during the daytime they are more like those from a quiet ionosphere. Oblique incidence transmission at night during an ionospheric storm also shows a high fading with distortion of modulation owing to multipath transmission, but the amplitude of the fading as a fraction of the main signal is considerably reduced. These phenomena indicate a reduction in the scale of irregularities of ionization in the F region at night during ionospheric storms.

There is evidence that ionospheric storms, like auroras, spread equatorward from the auroral zones. The frequency and intensity of ionospheric storms decrease from the auroral zones to the magnetic equator. On a few occasions, the blurred echoes on an ionospheric recorder have been observed to behave in such a way as to suggest that the portion of the F region containing storm-type irregularities of ionization was spreading equatorward over the observing stations. Appleton and Piggott [E. V. Appleton and W. R. Piggott, *J. Terrestrial Magnetism and Atm. Elec.* **2**, 236 (1952)] think that many ionospheric storms are unipolar in that they spread equatorward from the auroral zone in one hemisphere without simultaneously doing so in the other hemisphere. Comparatively little is known about the behavior of ionospheric storms on the poleward sides of the auroral zones.

No comprehensive theory of magnetic storms has yet been formulated, although certain relevant suggestions have been made by D. F. Martyn [D. F. Martyn, *Nature* **167**, 92 (1951)].

The Ratio of the Diameters of Hydrogen and Oxygen Molecules, Using Negative Pressure as an Indicator

Lyman J. Briggs, *National Bureau of Standards*

Measurement of the diameters of oxygen and hydrogen molecules by various investigators and methods [Dushman, *Scientific Foundations of Vacuum Technique* (1949), p. 43] lead to the following oxygen/hydrogen ratios: viscosity, 1.32 and 1.19; van der Waals constant, 1.06; density, 0.90; electron collision, 1.54. The method employed in the present work is based on the measurement of the minimum electric charge that, when suddenly applied to an electrode in a column of electrolyte under negative pressure, will cause the column to drop [L. J. Briggs, *J. Chem. Phys.* **21**, 779 (1953)].

The apparatus consists of a vertical glass tube (approximately 1 cm bore and 100 cm long) carrying at its closed upper end two opposed spherical platinum electrodes, approximately 1 and 2 mm in diameter. The lower end of the tube is bent upward in the form of a J, to which is attached a cylindrical reservoir. After introduction of sufficient electrolyte ($1N$ H_2SO_4) to more than fill the long tube, the system is evacuated and sealed off.

On rotation of the long tube to a vertical position, the column of liquid remains hanging from the top of the tube, under a negative pressure (at the top) equal to the length of the column down to the level of the meniscus, less the vapor pressure in the reservoir. The minimum charge required to drop the column may now be measured with a mica capacitor (adjustable in steps of 0.001 μf), which is first charged to a known potential and then connected to the electrodes. Hydrogen is deposited as an incomplete monomolecular film [L. J. Briggs, *loc. cit.*] when the smaller test electrode is the cathode; oxygen, when it is the anode.

After the critical anodic charge was divided by 2, since oxygen is bivalent, six series of measurements gave 0.985 ± 0.015 as the ratio of the number of O_2 to H_2 molecules required to drop the column. The reciprocal gives the relative areas covered, and its square root gives the relative diameters, $O_2/H_2 = 1.008 \pm 0.004$.

An Accessory Chromosomal Element Associated with Variegated Pericarp in Maize

R. A. Brink and P. C. Barclay
University of Wisconsin

The unstable P^{VV} allele, conditioning medium variegated pericarp in maize, is explainable in terms of a compound mendelizing unit that consists of the stable P^{RR} gene (red pericarp and cob) and an accessory element called Modulator which suppresses the pigment-producing action of P^{RR}. Medium variegated mutates frequently to

two complementary phenotypes, red and light variegated, which often appear as easily recognizable twin spots on the ear. The reds are stable. The light variegated mutants segregate lights and mediums, as is expected if they carry an unchanged P^{VV} allele and also are hemizygous for Modulator transposed to some locus other than *P*. Twins were postulated to arise in a differential mitosis in which (*a*) one daughter chromatid at the *P* locus becomes P^{RR} and the other remains P^{VV} and (*b*) the transposed Modulator gained by the light variegated is the Modulator lost in the red co-twin in the change from P^{VV} to P^{RR}. Tests show that plants grown from the red kernels of a twin spot lack Modulator, in accordance with this hypothesis. A third variegated phenotype, termed very light, which arose as a mutation from light variegated, was found to carry two transposed Modulators in different positions. Increasing dosages of Modulator reduce the frequency of mutations of variegated to red exponentially. Modulator is similar to McClintock's Activator (*Ac*) in that both "activate" Dissociation (*Ds*), an element which she has described as extragenic and promoting chromosome breakage and instability when present at other loci.

Extracellular Metabolic Products of *Escherichia coli* during Rapid Growth

Roy Britten, ***Carnegie Institution of Washington***

The metabolic products released into the culture fluid by rapidly growing cells of *Escherichia coli* have been studied. Using a synthetic medium containing C^{14}-labeled glucose as a principal carbon source, it has been possible to distinguish between the C^{14}-labeled compounds synthesized by the cells and the C^{12} compounds added as supplements.

In the absence of supplements, a complex pattern of metabolic products, including amino acids, was found. No individual compounds (with the exception of carbon dioxide and acetate) predominated, showing a close balance between the rates of synthesis and the requirements of the cell for growth.

When C^{12}-glutamate was added to the medium, it was used by the cells for protein synthesis. The cell, however, continued to form glutamate from glucose, and large quantities of C^{14}-labeled glutamate then appeared in the culture fluid. A similar situation was found using aspartate, glycine, alanine, and valine as supplements.

However, when C^{12}-proline was added to the medium, it was also used for protein synthesis; but its presence suppressed the synthesis of proline, and no C^{14}-proline could be found in the medium. Arginine, serine, methionine, and threonine gave similar results.

In some cases, more complicated effects occur, including the release of related metabolic products which are also C^{14}-labeled. These immediate responses of the cell to the presence of supplements give definite evidence for the biosynthesis of certain suspected intermediates and indicate striking differences in the physical chemistry of different reactions carried on by the cell. These observations supply some new clues to the factors that control the synthetic rates in the intact cell.

Transition Phenomena in Cosmic Radiation

Robert B. Brode, ***University of California, Berkeley***

The transition effects due to gamma rays, electrons, and mu mesons have been studied for the sea-level cosmic radiation as it passes through various thicknesses of carbon, aluminum, copper, cadmium, and lead. A sharp maximum in the number of narrow pairs due to gamma rays is observed at about one radiation length of the absorbing material. Showers due to gamma rays indicate a maximum in their frequency at about three radiation lengths of the absorber. The transition effect for incident charged particles is due to either electrons or mu mesons. The phenomena for these two types of incident particles have been separated. The electron contribution appears to be appreciably less important than the photon component but gives maxima for pairs and showers similar to the photon-produced curves. The knock-on electrons due to mu mesons are responsible for apparent pairs of particles. The low atomic number materials are more effective sources of knock-on electrons because of their higher critical energy and longer radiation lengths. No evidence was found for the second maximum in the Rossi transition curve reported by Bothe.

This work was assisted by the joint program of the U.S. Office of Naval Research and the U.S. Atomic Energy Commission.

On Planetary Cores

K. E. Bullen, ***California Institute of Technology***

Evidence for the solidity (in an appropriate sense) of the earth's inner core will be reviewed. The evidence includes consideration of compressibilities at pressures of the order of 10^6 atm as indicated by seismological data and interpolation between theoretical results for Thomas-Fermi-Dirac gases and Bridgman's experimental data at 10^5 atm. The prospects of proving the solidity by direct observation of seismic S waves in the inner core will be discussed. It will be concluded that there are good reasons to believe that the rigidity of the inner core lies between 1.5×10^{12} and 3.6×10^{12} dyne/cm^2.

The question of the composition of the whole central core of the earth will be discussed, especially the hypothesis that the outer part of the core may consist of modified silicate rock rather than nickel-iron. Relevant observational data on the masses and diameters of Mars, Venus, and Mercury and on the oblateness of Mars will be discussed. A firm conclusion will be drawn to the effect that each of these planets contains a proportion by mass of uncombined nickel-iron at least equal to the proportion by mass of the earth's inner core to the whole earth.

The Parenteral Utilization of Peptides in Tissue Protein Synthesis

Paul R. Cannon, Laurence E. Frazier, and Randolph H. Hughes

University of Chicago

Protein synthesis is commonly assumed to result from the intracellular utilization of amino acids. It is also believed by some that the process is rapid and that, so far as the essential amino acids are concerned, all are utilized practically simultaneously at the anabolic site. Whether peptides can be similarly utilized is uncertain. Aside from its theoretical interest there is a practical aspect in relation to the use of protein hydrolyzates in parenteral nutrition. These preparations vary considerably in peptide content, and there is evidence that peptides introduced into the blood stream may be largely excreted through the kidneys. It is not known, however, whether all peptides are nonutilizable under such circumstances.

We have studied this problem in the following way. Protein-depleted adult male rats were subjected to pro-

tein repletion by daily subcutaneous injections of a mixture of 16 amino acids in solution while they were being fed a "nonprotein" ration adequate in roughage, calories, vitamins, and salts. On such a regime the animals synthesized tissue protein and regained weight. However, when a single essential amino acid was omitted from the solution, weight loss quickly ensued. It was possible to substitute a synthetic peptide quantitatively for the appropriate essential amino acid in the solution without loss of nutritive potentiality. Six synthetic peptides were used: glycyl-L-Tryptophan, glycyl-L-Leucine, glycyl-DL-Phenylalanine, DL-Alanyl-DL-Phenylalanine, DL-Alanyl-DL-Methionine, and Leucyl-glycylglycine.

We conclude, therefore, that at least some simple peptides can be utilized parenterally in tissue protein synthesis.

A Miocene Swamp-Cypress Forest

Ralph W. Chaney, ***University of California, Berkeley***
and Daniel I. Axelrod,
University of California, Los Angeles

At many localities on the Columbia Plateau, forests of later Tertiary age have left a record of their leaves, fruits, pollens, and stems in volcanic ash interbedded with basaltic flows. The Mascall flora from the John Day Basin of Oregon has long been studied, but a sound interpretation of its relationships and environment has been delayed by the mistaken identification of its dominant conifers. Earlier referred to as *Sequoia* and considered to represent the ancestor of the living Coast redwood of California, these foliage and cone impressions have recently been found to represent two trees now growing on the *eastern* sides of the northern continents, *Taxodium*, of the southeastern United States, and *Metasequoia*, of central China. Living members of both these genera have a deciduous habit, in contrast to the evergreen *Sequoia*.

With our attention turned toward these regions characterized by summer-wet and winter-cold climate, we have found that a majority of the Mascall species are closely related to trees now living in and near the swamp-cypress forests of the Mississippi Basin; oaks, hickory, maple, and sweet-gum show marked resemblance to living species that are associates of *Taxodium distichum* in swampy lowlands. There is probably no other Tertiary flora in North America that has survived with so little change. The only major difference has been the disappearance from this continent of several members of this Miocene flora, of which *Metasequoia* is typical, which are now confined to Asia.

Utilization of Internal Sulfur Reservoirs by *Escherichia coli*

Dean B. Cowie, Richard B. Roberts, and Ellis T. Bolton
Carnegie Institution of Washington

The sulfur of *Escherichia coli* is distributed among three chemically distinct fractions of the cell: 25 to 30 percent of this sulfur is found in glutathione and can be extracted with cold trichloracetic acid; 10 to 15 percent is found in a protein fraction that is soluble in acidified alcohol; the remainder of the sulfur is bound in acid alcohol-insoluble proteins. When the cells grow with adequate sulfur present, there is a direct correlation between total sulfur uptake and protein synthesis; the protein-bound sulfur is stable, and no loss or exchange is observed.

When the cells are placed in a sulfur-free medium, growth continues at the optimal rate for a short period, during which the sulfur of glutathione is converted to protein. When the glutathione is depleted, the exponential growth rate abruptly drops by a factor of 10. During this period of slow growth, the alcohol-soluble protein is depleted of sulfur and carbon. Similar results are obtained even though methionine is present in the medium. When adequate sulfur is supplied to the depleted cells, growth resumes immediately at the optimal rate, the reservoirs are rapidly replenished, and the content and distribution of sulfur become normal.

It is concluded that these cells can respond to sulfur deficiency by transferring sulfur and carbon from glutathione and the alcohol-soluble protein fractions to the alcohol-insoluble proteins.

The Infra-red Rotation Spectrum of Methyl Alcohol

David M. Dennison, ***University of Michigan***

A theory of hindered rotation as it occurs in methyl alcohol was developed by Koehler and Dennison [*Phys. Rev.* 57, 1006 (1940)] using a simplified model. The energy levels were given as functions of the molecular dimensions and of the height of the hindering potential. The predicted rotation spectrum was so complex that no progress could be made in identifying the lines of the equally complex observed spectrum. A break in the stalemate occurred when Hershberger and Turkevich discovered a series of related lines in the microwave spectrum of methanol. These lines were subsequently measured with great accuracy by Coles and others, and the transitions involved could be identified uniquely [for references see R. H. Hughes, *et al.*, *Phys. Rev.* 84, 418 (1951)]. An improved theory served to explain most of the features of the microwave spectrum, to fix the low-lying energy levels, and to evaluate the molecular constants.

Knowing the molecular constants, it is now possible to calculate the higher rotation levels. Account has been taken of the effects of centrifugal distortion, which, while small, become significant for the states of rapid rotation. A comparison between the predicted and observed spectra has been made. The agreement is very satisfactory in the region from 16 to 30 μ, where the lines are relatively well separated. At wavelengths exceeding 30 μ, the lines fall so close together and the absorption is so intense that the correlation is less unambiguous.

Improvements in the Technique of Low-Angle X-ray Diffraction for the Study of Biological Materials

J. W. M. DuMond and Dwight Berreman
California Institute of Technology
and Burton Henke, ***Pomona College***

In the study of such biological objects as collagen, keratin, and hemoglobin virus, where the interesting structures may range in size from a few tens to a few thousands of angstroms so that the optical microscope has insufficient resolving power, the electron microscope is the tool that one naturally resorts to. Unfortunately, the electron microscope requires placing the sample in vacuum and, therefore, may profoundly modify it by desiccation. The use of x-rays to replace electrons circumvents this difficulty. To date, however, no very satisfactory technique of x-ray microscopy with results comparable to electron

microscopy has been developed, although work on this is being actively pursued. Another solution, however, is to study these biological objects by means of low-angle x-ray diffraction, a technique which admittedly has the disadvantage that it does not reveal the structures of individual particles or units but gives information regarding statistical average properties of a less direct nature. This information may, nevertheless, be of the greatest value and quite inaccessible in any other way.

At the California Institute of Technology, a program of work toward the improvement of the technique of low-angle x-ray diffraction supported by the Office of Naval Research has been under way for some years and has led to the development of several forms of a new instrument, the point-focusing x-ray monochromator, each of which is briefly described in this paper. The work has concentrated upon two x-ray wavelength domains: 1.4 angstrom units $CuK\alpha_1$ radiation and the much softer domain 13.3 (Cu-L radiation) to 31.6 angstroms (N-K radiation). Some diffraction patterns are shown, and proposed further improvements are discussed.

The Efficiency of Photosynthesis during Transient and Steady-Rate Conditions

Robert Emerson and Ruth V. Chalmers

University of Illinois

Efficiencies of photosynthesis approaching 100 percent have been reported by Warburg, Burk, and coworkers. They measured photosynthesis by observing gas exchange during periods of frequent changes in illumination. This implies certain assumptions regarding the equality of behavior of duplicate samples of cells. We have made experiments to test these assumptions and find that the technique they describe does not assure the required equality of behavior. Rates of photosynthesis measured by their technique are, therefore, of doubtful significance.

We have also tested a modification of their technique and can show that this provides for fulfillment of the required assumptions. Our measurements with this modified technique lead to somewhat lower efficiencies than the highest reported by Warburg and coworkers.

Our measurements also show that the selection of different time intervals for calculation of photosynthesis can lead to a wide range of efficiencies. Highest efficiencies can be calculated from certain periods of transient changes in rate, and periods of steady rate lead to much lower efficiencies. Moreover, during transient rates, the fluctuations in oxygen and carbon dioxide exchange suggest that at least part of the gas exchange may represent changes in metabolic intermediates rather than the production of carbohydrate and oxygen from carbon dioxide and water. Since the energy changes accompanying the formation and disappearance of intermediates are unknown, the calculation of energy efficiency from transient rates of gas exchange seems to be of but little significance.

Physics and Physiology of Neutron Capture Therapy

Lee E. Farr, James S. Robertson, and E. E. Stickley

Brookhaven National Laboratory

Neutron capture therapy is a procedure designed to achieve a strongly localized radiation treatment by inducing energetic heavy particles within the disease site. The technical feasibility of the procedure was shown in experimental trial on 10 patients with the malignant brain tumor, glioblastoma multiforme. Borax, with boron of mass number 10, injected intravenously was used as the capture element vehicle. Tumor dose was calculated from measurement of thermal neutron flux density, published nuclear data, and evaluation of selective kinetics of borax in the tumor. Physically, the radiation is limited by the range of the energized particles (alpha, lithium, or fission). Direct effects of slow neutrons are not significant in comparison with radiation mediated by the capture reaction. Dosimetry of thermal neutrons in tissue was based on studies of radioactivity induced in gold foils distributed in patients treated and throughout tissue equivalent phantoms exposed to the treatment neutron flux. Physiologically, the concept of selective kinetics has been developed at Brookhaven in contrast to previously suggested approaches utilizing preferential uptake as exemplified by dyes. The kinetics of distribution of elements through body water are characteristic of the tissue involved. When sufficient differences in rates of distribution occur, advantage can be taken of precise knowledge of the time of maximum concentration in the tissue to be destroyed. Thus a larger amount of target element is available for the neutron capture reaction than can be achieved at final equilibrium with any presently known substance.

This research was supported by the Atomic Energy Commission.

Geographic Basis for Antarctic Scientific Observation

L. M. Gould, *Carleton College*

An examination of the list of titles on this symposium automatically emphasizes the urgency of including Antarctic observations during the International Geophysical Year. All deal with phenomena that are world-wide in their manifestations. There is not a field of study that will not receive definitive results from Antarctic observations and some, such as the Aurora Australis, are uniquely dependent upon observations not otherwise obtainable.

Antarctica has unique geographic aspects which emphasize the preceding statements. It is the only polar continent; furthermore its mass is roughly circumpolar in its distribution. It is the only "insular" continent. All other continental landmasses are actually connected with land bridges or separated at most by shallow seas. Antarctica is completely surrounded by oceanic waters of wide extent. Antarctica has an average altitude of a mile above sea level—higher than that of any other continent. It is the only continent completely covered by an icecap or continental glacier.

Electrification of Mist and Drizzle

Ross Gunn, *United States Weather Bureau*

A theoretical and experimental investigation of the electric charging of moving drops by ionic diffusion has been completed. In an environment containing both positive and negative ions, but neglecting space charge, expressions have been obtained for the rate of diffusion of ions onto a moving sphere and for the equilibrium free charge thereby established. This free charge is proportional to the logarithm of the ratio of the positive- and negative-ion conductivities and to a factor depending on the size and velocity of the sphere relative to its ionized environment. The derived relationships have been verified by laboratory measurements.

In the lower atmosphere, the positive-ion conductivity nearly always exceeds the negative conductivity; hence, droplets falling through such an atmosphere should acquire a free positive charge. F. J. Scrase [*Electricity on Rain*, Met. Office Geophysical Mem. 75 (1938)] has measured the free electric charge transported to the earth throughout a 2-yr interval and found that 93 percent of the precipitated mist and drizzle carried positive charges. By employing droplet diameters characteristic of mist and drizzle, it is found that the derived relationships closely predict Scrase's measured free charge per gram of water, namely, 0.46 esu/g.

It is concluded that ionic diffusion to droplets falling through the free atmosphere plays an important role in precipitation electricity. By assuming that such processes systematically clear out from the atmosphere ions of a selected sign and, thereby, leave excessive numbers of oppositely charged ions to be swept onto droplets that fall later, one may quantitatively describe the observed charges brought down by all types of rain.

In Vitro Analysis of a Diffusible Agent of Mouse Sarcomas that Promotes Nerve Growth in Chick Embryos

Viktor Hamburger, *Washington University*

Previous experiments have shown that mouse sarcomas 37 and 180 produce a diffusible agent that promotes selectively the growth and nerve fiber production of sympathetic and spinal ganglia of chick embryos, whereas somatic motor, preganglionic, and parasympathetic neurons are refractory. These results were obtained *in vivo* by transplantation of tumor pieces intra-embryonically or onto the extra-embryonic membranes of 3-day chick embryos. The supernumerary nerve fibers emerging from the hyperplastic ganglia flooded the adjacent viscera, which normally have a very sparse innervation or none at all, in corresponding stages.

Tissue culture experiments made in this laboratory by R. Levi-Montalcini have shown that part of these phenomena can be reproduced *in vitro*. When isolated spinal or sympathetic ganglia of 8- to 12-day chick embryos are grown adjacent to fragments of mouse sarcoma, an extraordinary number of radially oriented nerve fibers emerge from the ganglia. The maximal effect is reached at 24 hr, at which time control cultures show little or no growth. The target-specificity is the same as *in vivo*; motor neurons are refractory.

Fractionation experiments of the tumor (in collaboration with Stanley Cohen), using sucrose, indicate that the active principle is concentrated in the microsome fraction. The active agent can then be precipitated completely by the streptomycin procedure for the isolation of nucleo-proteins. The agent is heat-labile and nondialyzable. Its absorption spectrum is typical of nucleo-proteins.

This research was supported by a grant from the Rockefeller Foundation and by a Research Grant (C-1801) from the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

Analysis of the Luminescent Response of the Ctenophore, Mnemiopsis, to Stimulation

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Princeton University

The luminous tissue of Mnemiopsis within the radial canals responds to electrical or mechanical stimulation directly or through nerves by a flash of greenish light. Records have been taken with photomultiplier-cathode-ray oscillograph-camera recorder of the response to electrical stimulation of small bits of luminous tissue. The relationship of light emission to strength and duration of stimulus, repetitive stimuli, and fatigue at different temperatures has been particularly studied.

The response is remarkably like that of muscle. At 21° to 23° C with single square-wave stimulation and a small piece of tissue, a single flash appears having a latent period that varies considerably, a half-rise time of 35, a maximum-peak time of 60, a half-decay time of 48, and a 0.9-decay time of 114 milliseconds. Lowering the temperature prolongs the time course of single flashes, especially the decay phase. Raising the temperature has the opposite effect. Light intensity increases as strength of stimulus increases, and repetitive stimuli elicit responses similar to summation of twitches, treppe, incomplete and complete tetanus of muscle. Fatigue appears soon and is a marked characteristic of the luminescent response. Repetitive flashes after a single stimulus have been observed in large pieces of tissue. The conduction rate of a luminous excitation along the canals averages 14 cm/sec. Bursts of action potentials, simultaneous with the luminescent responses, appear.

The Joinability of Chromosome Breakage Points Produced by X-rays in *Drosophila* Oocytes

Irwin H. Herskowitz
Indiana University

Following x-irradiation of spermatozoa, gross chromosomal rearrangements resulting from unions between breakage points produced either far apart in a chromosome or in different chromosomes are abundant, but they are reported to be rare when oocytes are treated. One possible interpretation lies in experiments by Rapoport, indicating that in irradiated oocytes points of breakage can become unjoinable and stabilized ("healed") as distal ends ("telomeres"). Because, after irradiation of spermatozoa, this happens less frequently, if ever.

In the present experiments, oocytes, containing an attached-X but no Y chromosome, were x-rayed with 1000 and 4000 r to obtain the detachments of the arms of the attached-X, which in Rapoport's view represent "healed" breakages. These detachments were at least 4 percent when the most mature oocytes received 4000 r, decreasing for oocytes that were younger when treated. The frequency of detachments increased approximately as the 3/2 power of the dosage, demonstrating that most, if not all, of these cases required more than a single event (break) for their production. By genetic tests, a considerable proportion was proved to consist of translocations and gross deletions. The data indicate a less random distribution of the breakage points among the autosomes partaking in translocations in the case of oocytes than is known for spermatozoa.

These observations make untenable the view that new telomeres are formed following x-ray breakage of oocyte chromosomes. They suggest that the orientation of the chromosomes during and after irradiation is a major factor influencing the numbers and kinds of joinings by points of chromosome breakage.

Intermolecular Forces between Chemically Active Molecules, for example, Nitric Oxide

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In collisions of free atoms, free radicals, electronically excited molecules, or conjugate double-bond molecules, there are long-range or directional forces that are interesting to contemplate. For example, when two nitric oxide molecules collide, owing to quantum mechanical resonance, there should be a strong interaction at a separation of the order of 15 A, provided that one of the molecules is in the $^2\Pi_{1/2}$ ground state and the other is in the low-lying $^2\Pi_{3/2}$ excited state. Since nitric oxide molecules have quadrupole moments, their energy of interaction must be expressed in terms of four, rather than one, potential energy curves. The probability of a particular collision following any one of these potential curves can be estimated *a priori* from statistical considerations. Because of these anomalous effects, we expect that nitric oxide should have an anomalously large cross section for thermal diffusion, which should assist in the separation of oxygen and nitrogen isotopes. Neither quantum mechanical resonance nor quadrupole-quadrupole forces should have an appreciable effect on the equation of state of the gas, but they should have a large effect on the transport properties.

Another type of force comes into play when two conjugate double-bond molecules collide. Such molecules have pi electrons that can move freely over the conjugate double-bond system. Thus, conjugate double-bond molecules behave like extended oscillators with a variety of nodes and antinodes in the electric fields surrounding them.

Further knowledge of intermolecular forces will come from quantum mechanical predictions on qualitative behavior, together with empirical studies of physical properties of materials.

Fungitoxicity of Sulfur-Bridged Compounds

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The mechanism of antifungal action of sulfur was studied further by offering sulfur-bridged compounds to germinating spores of *Monilinia fructicola*, a known sulfur-sensitive fungus. Diphenyl sulfide and β-nonylmercaptopropionic acid were active, but their sulfone analogs were not, thus suggesting that the activity depends on unfilled valencies of the sulfur atom. Among the most active compounds were N-(trichloromethylthio)-1,2,3,6-tetrahydrophthalimide, 2,4-dinitrophenylthiocyanate, benzothiazolyl-2-thioglycolic acid, and diphenyl sulfide. The striking characteristic of these compounds is that the sulfur bridge is between two electronegative groups: C=O, —CCl_3, —C≡N, —COOH, or benzene ring. It may be assumed that the electronegative groups tend to withdraw electrons from the sulfur, making it even more reactive. Also, bis(2-hydroxy-5-chlorophenyl) sulfide was more toxic than bis(2-aminophenyl) sulfide, which in turn was more toxic than diphenyl sulfide. It may be assumed that the *o*-hydroxyl and *o*-amino groups can act with the nearby sulfur to form metal chelates that rob the organism of needed metals.

DL-methionine is a sulfur-bridged natural compound, which, of course is not toxic. It contains, however, only a single electronegative carboxyl group, and even this is balanced by an electropositive —NH_2 group between the carboxyl group and the sulfur bridge.

Sometimes, poor permeation confuses the activity picture. Benzothiazolyl-2-thioglycolic acid is more toxic than the K-salt, presumably because, not being as strongly ionized, it penetrates better.

Carbohydrate Metabolism in Mammalian Placenta

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The placenta passes glucose from the maternal blood to the fetus (*1*), and in the Ungulata it also converts glucose into fructose (*1*), which in this group of mammals forms the larger part of the fetal blood sugar.

This formation of fructose occurs not only with hyperglycemic levels but also at normal blood sugar levels, as shown by the use of C^{14}-glucose (*2*). It is formed by the placenta, but not by the fetus, and at a constant rate of approximately 12 mg/min. The removal by the placental and fetal tissues of fructose is dependent on the level of circulating glucose. Increase in glucose concentration depresses the fructose utilization (*3*).

The fetal blood glucose production by the placenta depends on the level of glucose in the maternal and fetal bloods. Glucose differs from fructose in that it goes back freely to the mother. Further, the placental cells actively transport glucose in both directions; diffusion is inadequate to explain its passage, which is best explained on the carrier hypothesis of Widdas (*4*).

The carbohydrate metabolism of the placenta groups them into two main groups: those with little or no fructose in the fetal blood (*5*) and considerable glycogen in the placenta (rodents) (*6*); those with considerable fructose in the fetal blood and little glycogen in the placenta (Ungulata). The primates appear to be a special class partaking of both states, although to a small degree.

This work was supported by grants from the Medical and Agricultural Research Councils of Great Britain.

References: (1) Huggett, *et al.*, *J. Physiol.* **113**, 258 (1951); (2) Alexander, *et al.*, *J. Physiol.* **115**, 36P (1951); (3) Alexander, *et al. J. Physiol.* **118**, 58P (1952); (4) Widdas, *J. Physiol.* **118**, 23 (1952); (5) Goodwin, *Nature* **170**, 750 (1952); (6) Huggett, *J. Physiol.* **67**, 360 (1929).

Induction of Growth with Monofunctional Steroids

Charles Huggins and Elwood V. Jensen

University of Chicago

Functional groups at the C_3 or C_{17} positions of steroids are essential for the promotion of growth by these compounds. An evaluation was made of the effect of position and of the state of oxidation of side groups of both monofunctional and difunctional steroids upon biological indicators that are highly sensitive in reflecting growth. The test objects were the uterus and vagina of the hypophysectomized rat protected from contact with extraneous steroids by feeding a synthetic ration.

Although monofunctional steroids are less active than those with two side groups, a single 17β-hydroxyl group endows steroids in the androstane series with considerable growth-promoting activity. Similar C_{20} steroids with a 3β-hydroxyl group as the sole function have merely a trace of, or no, activity in a dosage as high as 3 mg daily. Monofunctional steroids with a ketone group at C_3

or C_{17} do not induce growth. Thus, in monofunctional steroids, the cyclopentanol structure of ring D has far greater activity than the cyclohexanol of ring A in promoting growth of secondary-sex structures of the rat.

Monofunctional steroids containing a phenolic group at C_3 cause marked stimulation of the uterus and vagina.

The Scientific Program of the International Geophysical Year

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The principal subjects now included in the scientific program of the International Geophysical Year are aurora and airglow, cosmic rays, geomagnetism, glaciology, ionospheric physics, longtitude and latitude, meteorology, solar activity, oceanography, and the rocket exploration of the upper atmosphere. The close relationships among these subjects, the guiding principles of the planning for this program, and some of the most important goals of the program will be presented.

The Study of the Nonlinear Alternating Gradient Synchrotron Using a Digital Computer

D. W. Kerst and J. N. Snyder, ***University of Illinois***
and J. L. Powell, ***University of Wisconsin***

The linear theory of the alternating gradient synchrotron [Courant, Livingston, and Snyder, *Phys. Rev.* **88**, 1190 (1952)] is well developed, but an accelerator built with linear restoring forces has many dangerous orbit resonances that must be avoided by conservative design and by close tolerances. To learn whether nonlinear restoring forces can be used to avoid these resonances, the University of Illinois Digital Computer (Illiac) is being used by the Midwestern Accelerator Group. The differential equations treated are

$$x'' = nx - \frac{e}{3}x^3 + e\,x\,y^2,$$

$$y'' = -ny - \frac{e}{3}y^3 + e\,y\,x^2,$$

where n is constant but changes sign abruptly many times during one revolution of the particle about the machine; e may or may not change sign. The Illiac displays, accurately and numerically, the coupled solutions of these equations.

Photographs of the oscillographic display that was built by the computer laboratory can be taken at the rate of 15 betatron oscillations per minute. Usually, 20 Runge-Kutta points are plotted in a sector. In addition, phase diagrams and x vs. y diagrams can be plotted in a few minutes.

Of several hundred cases examined, typical examples will be shown. One of these examples, a class of motion of special interest that was pointed out by H. R. Crane, is motion locked into the machine by lens forces or by inhomogeneities. Such mathematical experimentation on a wide range of cases aids in understanding the general features of nonlinear motion, and it has proved useful in formulating analytic approaches.

Periodic Structure in the Flagella and Cell Walls of a Bacterium as Shown by Electron Microscopy

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National Institutes of Health.

The peritrichous flagella of a noncapsulated motile nonspore-forming gram-negative bacterium are shown by electron microscopy to have a helical structure. Each flagellum has a diameter of about 150 A and appears to be a tightly wound counterclockwise helix of a 130-A diameter fiber. The pitch of the helix varies between 25 and 35 deg.

The cell wall of this bacterium is composed wholly or in part of a membrane that shows no regular structure on its outside surface but has a rectangular array with a periodicity in each direction of about 115 A on its inside surface. The thickness of this membrane appears to be about 75 A.

Absolute Free Energies and Entropies of Aqueous Ions

Wendell M. Latimer, ***University of California, Berkeley***

The absolute free energies are now known with considerable accuracy for combinations of all the common positive and negative ions in aqueous solutions, as for example, $Na^+ + Cl^-$, $Ca^{++} - Mg^{++}$ or $I^- - Br^-$. The assignment of absolute values to the individual ions is still highly questionable. The theoretical Born equation for the reaction, ion (gas) = ion (aqueous), $\Delta F = -Z^2/2r\,(1-1/K)$ has the limitation that the effective dielectric constant K and the ion radius (or ion cavity) r are not known. Latimer, Pitzer, and Slansky [*J. Chem. Phys.* **7**, 108 (1939)] proposed values for the effective "Born radii" that would make the free energies of both the positive and the negative ions fall on the theoretical curve ΔF vs. $1/r$, but there has been no substantiation of this assignment. However, it may now be shown that an assignment of absolute entropies, based upon the value $\overline{S}_{H^+} = -2.1$ eu, as determined by Eastman and students [Goodrich, *et al. J. Am. Chem. Soc.* **72**, 4411 (1950)] leads to values for the entropy of hydration ΔS that are simply related to the ΔF values given by Latimer, Pitzer, and Slansky. Since ΔS is the temperature coefficient of ΔF, such a relationship should exist if the correct absolute values have been assigned to both quantities. The relationship between ΔS and ΔF is highly sensitive to the value of $\overline{S}_{H^+}$ and limits the absolute value of the entropy of H^+ to -2.1 ± 1 entropy units.

The entropies of hydration, using the "Born radii," are a function of Z/r and not Z^2/r. This may imply that the change of the radius of the ion cavity with temperature contributes more than the change of the dielectric constant.

The Morphology of the Aurora

A. B. Meinel, ***Yerkes Observatory, University of Chicago***

As scientists throughout the world turn their attention to the oncoming International Geophysical Year activities, one of the fields of special interest is the polar aurora. The aurora is a polar phenomenon and does not yield itself to easy study. Since the aurora presents one of the most baffling of natural phenomena and is of great synoptic complexity, further progress will require combined effort.

The aurora is not a phenomenon to be associated exclusively with an unusual set of events, although large auroral storms frequently may follow violent outbursts of solar activity. Auroras may be seen as often as one out of two clear nights in the auroral belt.

Observational evidence now leads us to believe that there are two separate phases to a typical aurora. The aurora generally begins as a homogeneous arc stretching

from horizon to horizon. The second phase can set in abruptly at any time with the arc breaking up into beautiful rayed structures. The spectrograph reveals that a subtle but profound change has occurred. The bombarding solar material, easily evident during the arc stage is no longer observed.

While the main problem is to explain these and many other interesting observations, more tangible benefits result, since the aurora constitutes an inexpensive probe of the upper atmosphere. With the spectrograph, radar transmitter, and other tools, we find intimate facts about our upper atmosphere. In an age when man must seriously consider his atmosphere some 50–100 mi above the surface of the earth, this knowledge takes on practical importance.

Solar Activity and Terrestrial Disturbances

Donald H. Menzel, ***Harvard College Observatory***

Although scientists have long recognized that magnetic storms, auroras, and various types of ionospheric disturbances arise from solar activity, we cannot identify the exact regions on the sun responsible for these terrestrial effects. In some cases the "M region"—that is, the area responsible for magnetic activity—appears to be merely an active spot group. But the fact that strong magnetic disturbances may occur when the sun is completely without spots indicates that the problem is not simple.

The majority of workers agree that clouds of ions, drifting toward the earth cause the disturbances, so the problem is one of locating the solar source of these clouds. Motion-picture records show that sunspots may eject intense surges or geysers of hot, luminous gas.

Theoretical studies indicate that the ejected matter may carry intense electric currents, up to 10^{10} amp or more. The expansive forces associated with a current loop elevate the prominence material against gravity.

Some recent studies of the solar "spicules," the bubbling activity near the solar poles discovered by W. O. Roberts, indicate that these geysers, too, may be current loops. If they are, then we may expect interplanetary space to be filled with innumerable gaseous current loops, like smoke rings. Some come from active spots and others from the solar regions near the pole. The "pinch effect" caused by the current will tend to hold the loop together and keep it from dispersing into space. These rings of gas would act, in a terrestrial encounter, very much like the ion stream discussed by Chapman.

Electronic Reproduction of Wide-Range Signals

Harry F. Olson, ***Radio Corporation of America***

The storage of information in the form of reproducible electronic signals plays an important part in the fields of communication, education, business, industry, and manufacturing. For example, the electronic recording of audio signals for electronic reproduction at any convenient and subsequent time, as exemplified by the phonograph and sound motion picture, plays an important role in the dissemination of information, art, and culture. There are many different means for the storage and reproduction of information in the form of electronic signals. For example, the possibility of the magnetic storage of information has been known for more than a half-century. However, only within the last few years have theories, techniques, and materials been developed that make it possible to store relatively large amounts of information by means of the magnetic system.

In the latest magnetic tape systems, the entire audio-frequency range can be reproduced with a realizable signal-to-noise ratio of more than 70 decibels. A signal of more than 3 megacycles can be reproduced with a realizable signal-to-noise of more than 20 decibels. In the latter system, more than 15,000 cycles per linear inch of the tape have been recorded.

A storage system capable of holding a large quantity of information that can be easily reproduced at any time has applications in many fields. A few of these are recording and reproducing audio signals; recording and reproducing television signals; the coding of signals in both audio and video reproduction; the grading of examinations and storage of grades in schools; a readily accessible storage system for computers; the recording of inventories, payments, receipts, and services in business; the controlling of machines in factories.

The Radioactivity of the Ocean

Hans Pettersson, ***Scripps Institution of Oceanography***

The much debated origin of deep-sea radium was explained through teamwork by Scandinavian and Austrian research workers. Ionium produced from uranium in sea water becomes coprecipitated with iron onto the bottom, there giving rise to radium. From a near-surface maximum, where radioactive equilibrium has been attained between radium and ionium after about 10,000 yr both elements decrease downward, according to the disintegration rate of ionium. Hopes for an exact geochronology of deep-sea deposits extending over several hundred thousand years have been based on radium measurements on sediment cores by Piggot and Urry but are not supported by recent measurements made in Göteborg, which prove the vertical distribution of radium in deep-sea cores to be much less regular than would follow from theory. Approximate values for the sedimentation rate of Pacific Red clay, derived from these measurements, give values between 1 and 3 mm in 1000 yr. Alternative explanations for the irregularities in the radium curves are being put forward by V. Kröll in the "Reports of the Swedish Deep-Sea Expedition." Recently developed methods for measuring uranium and ionium in the deposits support the ionium-precipitation hypothesis, proving the high radium content in the surface layers to be ionium-supported, whereas the much lower values farther down in the sediment are due to uranium-supported radium. Tentative conclusions from the radium distribution are drawn regarding past variations in the uranium and ionium content of ocean waters and also regarding past submarine volcanic activity in great depths.

Diurnal and Seasonal Variation of the Airglow

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For several decades, it has been known that there exists a faint background glow in the night sky. That the glow is of terrestrial (atmospheric) origin is established by the nature of its variation in intensity over the sky. The principal known contributors to the glow are atomic oxygen and sodium, molecular oxygen, and the radical OH. The atomic radiations have been systematically observed at Cactus Peak, California, for 5 years and some generalizations are now possible.

During the night, the intensities vary but not according to the same pattern for each color. The forbidden oxygen radiation in the green at 5577 A (transition $^1S_0 \rightarrow {}^1D_2$) usually exhibits a maximum of intensity near

the middle of the night. On the other hand, another forbidden oxygen radiation in the red at 6300 Å ($^1D_2 \rightarrow {}^3P_2$) usually exhibits a maximum of intensity at the very beginning of the night, steadily decreasing in intensity until about midnight followed by a slight rise toward morning. Sodium D is rather sporadic in its nocturnal changes with a general tendency to increase in intensity during the night. Simultaneous observations at two stations separated in longitude have given evidence that the gross diurnal variations are dependent on the local time of the observer and, hence, on the interval of time since the sun has energized the upper atmosphere.

The seasonal variation of 5893 is characterized by a maximum of intensity in the winter about 5 times the minimum in the summer. The two oxygen radiations have very slight winter maxima, which are largely obscured by the sporadic changes from night to night.

During the International Geophysical Year, it is planned to set up a number of observing stations for the study of the night airglow. Among the problems of general interest are (i) the relationship, if any, between the airglow and the polar aurora, (ii) the nature of the latitude variation of the airglow intensity and its diurnal changes, (iii) the systematic study of the seasonal changes of intensity with special reference to a comparison of the Northern and Southern Hemispheres.

Control of Tree Growth by Phloem Blocks

Karl Sax, ***Harvard University***

It has long been known that tree growth can be checked, and earlier fruiting induced, by girdling or killing the bark, thus preventing the flow of organic nutrients down the phloem into the root system. More recently, it has been shown that the killing of a section of the stem prevents the downward movement of organic carbohydrates and nitrogen, vitamins, auxin, and exogenous growth regulators.

A phloem block can be induced without killing a section of the stem by inverting a ring of bark or by irradiating a stem segment with x-rays. In both cases, the phloem block is induced by the suppression of cell division, which prevents the renewal of phloem elements. In the case of the irradiation block, nuclear division is suppressed without killing the tissue. The reversed polarity of the phloem cells in the inverted bark prevents the renewal of sieve tubes by checking the flow of nutrients and auxins necessary for all division.

The bark inversion technique can be modified to produce varying degrees of dwarfing of fruit and ornamental trees.

The Glass Electrode in Water-Methanol Solutions

Theodore Shedlovsky, ***Rockefeller Institute for Medical Research***

The familiar electrochemical cell (A),

$$\mathrm{Hg, HgCl \,|\, KCl(H_2O)\ (saturated) \,||\, solution\ X \,|\, glass \,|\, HCl \,|\, AgCl, Ag,}$$

is used for determining the *p*H of aqueous solutions X. The emf of this cell depends on the potential difference between the glass and the solution X and also on the corresponding change in the liquid junction potential as X is altered, both of these factors being included in the measured *p*H and in its scale.

To establish the *p*H scale for solutions in solvents consisting of water and methyl alcohol mixtures, measurements are made in cell (B), which is similar to cell (A) except for the fact that the saturated KCl is in the same solvent mixture as in the solution X. Moreover, the *p*K (ionization constant) values are determined from conductance measurements on the buffer acids in these solvents. Also, the behavior of the glass membranes as hydrogen-ion electrodes in these solutions is established by direct comparison with platinum-hydrogen electrodes.

The magnitude of the errors introduced in the determination of "*p*H" with cell (A) for solutions containing methyl alcohol can be estimated by comparing the emf values with corresponding ones in cell (B).

Problems of Gene Structure: III. Relationship of Unequal Crossing-Over to the Interdependence of R^r Elements (S) and (P)

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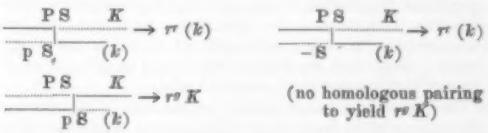
University of Missouri

The apparent lowering of the mutation rate of (S) by the mutation of (P), observed in certain R^r/R^g cultures (see paper I, this series) may be explainable by unequal crossing-over within the *R* complex (paper II), if the following assumptions are valid.

1) That mutant R^g's showing this effect are of constitution (−S) rather than (p S).

2) That, while two types of crossover mutants should be expected in progenies from compounds of R^r with R^g mutants of (p S) constitution, one of these should be rare or absent in progenies from similar compounds with R^g mutants of (−S) constitution, because of the pairing relationships indicated below:



3) That the r^r mutants in R^r/R^g (−S) progenies are due in large proportion to unequal crossing-over rather than to gene mutation.

Preliminary data on the compound $R^r K/R^g$–14 support this possibility. In a test of about 30,000 ♀ gametes, it yielded 12 r^r mutants (6 nonercossovers, $r^r K$) and 6 crossovers ($r^r k$), and 1 r^g mutant, a noncrossover ($r^g k$). The ♀ transmission ratio for chromosomes with and without *K* was approximately 75 : 25.

The proportion of crossovers among the r^r mutants, adjusted for the transmission advantage of chromosomes bearing *K*, is 75 percent. There were no $r^g K$ crossovers, although with equal frequency of occurrence of the two crossover types, 75 percent of the crossovers detected should be of this type.

Since the crossover type missing in the R^r/R^g–14 progenies occurs as expected in R^r/R^r progenies, the results indicate that R^g–14 is deficient for element (P).

Transfer of Antibody-Forming Capacity in Splenic Materials

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University of Chicago

Donor rabbits have been immunized by the intravenous

route at 1- to 3-day intervals for 42 days with boiled sheep red cell stromata and spleens removed at various stages during the process of immunization, minced and injected intravenously into (*a*) normal and (*b*) x-irradiated recipient rabbits. So far, appreciable degrees of lysogenesis, as indicated by a rise in antibody (measured photometrically in 50-percent hemolytic units) in the recipients, have been found only when antibody was rising to peak titer in the donor animal (4th to 8th day). Little, if any, antibody-forming capacity was present in the donors during the induction period (0 to 3rd day) or after peak titer (9th to 42nd day). The rise in the recipients was not due to antigen, because it occurred equally well in x-rayed recipients. The antibody rise was not due to passive transfer of serum antibody, because (i) the rise did not occur immediately and (ii) there was insufficient antibody in the spleen mince to account for it. No intracellular antibody could be demonstrated by distilled water lysis of the splenic cells. It was probably due to the transfer of cells that had acquired the capacity to form antibodies. The repeatedly injected donor rabbits after peak titer have been found to be in a refractory phase, during which continued antigenic stimulation incites no increased antibody formation. It is noteworthy that, during this stage, the splenic cells did not possess the lysogenic capacity. So far, lysogenic capacity has been found only in the spleen.

The Transformation of Cortisone into Corticosterone

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Recently, Mattox (*1*) observed that derivatives of both pregnane-17α,21-diol-20-one and of Δ^{16}-pregnene-21-ol-20-one are transformed by methanolic hydrogen chloride into systems bearing a glyoxal 21,21-dimethyl acetal side chain; thus, cortisone acetate was found to give Δ^{4}-pregnene-3,11,20-trione-21-al dimethyl acetal.

In the present investigation, application of the Mattox conditions to hydrocortisone acetate was found to bring about the same rearrangement of the side chain without involving the 11β-hydroxyl group. The retention of the latter group is in contrast with earlier observations (*2*) that 11β-hydroxysteroids are readily dehydrated to the corresponding $\Delta^{9,11}$-anhydro compounds. Like hydrocortisone acetate, the anhydro derivative, $\Delta^{4,9(11)}$-pregnadiene-17α,21-diol-3,20-dione 21 acetate, also undergoes the side-chain rearrangement without involving other functional groups.

Reduction of either Δ^{4}-pregnene-11β-ol-3,20-dione-21-al dimethyl acetal or Δ^{4}-pregnene-3,11,20-trione-21-al dimethyl acetal with lithium aluminum hydride gave a mixture of epimeric triols in which the predominant configurations of the pertinent hydroxyl groups are probably 3β, 11β, and 20β. The triol mixture was converted by manganese dioxide in benzene into Δ^{4}-pregnene-11β,20β-diol-3-one-21-al dimethyl acetal. Hydrolysis of the latter under carefully controlled conditions gave a poorly defined product in which the aldehyde carbonyl group was largely masked (infrared study), suggesting polymeric forms (*3*). On treatment of the hydrolysis product with pyridine, rearrangement of the glyoxal side chain occurred with the formation of corticosterone, Δ^{4}-pregnene-11β,21-diol-3,20-dione. A better yield of corticosterone was obtained by treatment of the hydrolysis product with sodium bisulfite followed by reaction of the isolated sodium bisulfite addition product with sodium methoxide in methanol.

References: (*1*) V. R. Mattox, *J. Am. Chem. Soc.* **74**, 4340 (1952); (*2*) C. W. Shoppee and T. Reichstein, *Helv. Chim. Acta* **26**, 1316 (1943); R. P. Graber, A. C. Haven, Jr., and N. L. Wendler, *J. Am. Chem Soc.* **75**, 4722 (1953); (*3*) W. Schindler, H. Frey, and T. Reichstein, *Helv. Chim. Acta* **24**, 360 (1941).

Fractionation of Silicates and Metal in the Planets and Meteorites

Harold C. Urey, *University of Chicago*

The variation in densities of the terrestrial planets and the existence of two groups of meteorites having different ratios of silicate to metal and different total iron contents indicate that chemical fractionation of the iron from the other "nonvolatile" constituents occurred during the formation of the solar system. Previously it was suggested that this occurred by evaporation of silicates. An alternative process of loss of silicates by splashing of silicates during collisions will be presented. This process is suggested by the structures of chondritic meteorites and the processes that occurred on the moon during the formation of its surface.

A brief presentation of possible sources of the high temperatures will be given. These processes include a temporary high luminosity of the sun, heating of asteroidal-type objects in protoplanets due to adiabatic compression of gases, and possible processes during the formation of the solar nebulae. Of these, the second appears most probable. In such processes, little separation of the more volatile from the less volatile elements of the "nonvolatile" fraction of cosmic matter has occurred.

An Application of High-Speed Computing to Fermat's Last Theorem

H. S. Vandiver, *University of Texas*
and D. H. Lehmer and Emma Lehmer
University of California, Berkeley

The statement of Fermat (known as Fermat's Last Theorem), which dates from 1672, that

$$x^n + y^n = z^n, \; n > 2, \qquad (1)$$

has no nonzero solutions in integers still awaits a proof or disproof. It is known that for a proof it is sufficient to consider the case of $n = l$, an odd prime.

By means of criteria devised by E. E. Kummer (1850 and 1857) and by H. S. Vandiver (1929 and 1934), it was possible to examine Eq. (1) for each exponent $n = l$, and the necessary tests were carried out by Kummer, Vandiver, and some collaborators of the latter for all $l < 619$. At this point, the calculations became prohibitively long and laborious for desk calculator work.

It is the object of this paper to show how the program has been carried out for all primes < 2000 in a few hours using the high-speed calculating machine of the National Bureau of Standards known as the SWAC at the Institute for Numerical Analysis in Los Angeles, as coded by D. H. and Emma Lehmer. As a result of this work, we are able to state that Fermat's Last Theorem is true for all exponents < 2000, or in effect, Eq. (1) is impossible in nonzero integers for all exponents $n < 2001$.

The results obtained also have many applications to the theory of algebraic fields defined by roots of unity.

Vitamin A and Skin Keratinization *in Vitro*: Experimental Dissociation of Induction and Realization Phases in Cytodifferentiation

Paul Weiss and Ruth James
University of Chicago

Experiments were undertaken to disengage the dual functions of cellular environment in cytodifferentiation: (i) activation ("induction") of a given course and (ii) continuous support for its realization. Fell and Mellanby (1953) noted that embryonic chick skin explanted to normal plasma keratinizes but, in the presence of excess vitamin A, produces mucoid cells instead. In our experiments, the vitamin treatment was made to precede actual culturing. Earlier, we had found that cells of 6- to 8-day embryo skin dissociated by trypsin, reaggregated, and cultured in normal plasma produce typical squamous keratinizing epidermis. In the present series, the dissociated cells were suspended for 30 to 60 min in a solution of vitamin A in alcohol; controls were in alcohol alone. Both lots were then treated alike: washed repeatedly and cultured in normal plasma, with transfers every second day.

The control (alcohol-treated) cultures developed typical squamous layering, followed by keratinization and desquamation at 12 to 13 days total age. Contrastingly, cells passed through vitamin A formed cuboid to columnar epithelia, with no (or abortive) keratin formation during the same period. Full mucoid metaplasia has not yet been obtained, presumably because of insufficient survival times. However, the mere fact that transient exposure to vitamin A for half an hour alters morphological and physiological cell behavior for at least 5 days of subsequent growth in normal medium points to the "inducing" rather than "supporting" role of that agent in this instance. This seems to furnish a pertinent model for mechanisms involved in cell transformation (differentiation and metaplasia).

This work was aided by the Abbott Fund (University of Chicago) and the American Cancer Society (Committee on Growth NRC).

Transport Problems in the Atmosphere

H. Wexler, ***U.S. Weather Bureau***

Three-dimensional transport of various meteorological properties, such as mass, momentum, heat, and water vapor, is examined. Atmospheric flow patterns associated with the major modes of transport are discussed. Deficiencies in knowledge, both of the distribution of the meteorological properties and the intensity and mechanism of their transport, are pointed out.

Evidence for Winds in the Outer Atmosphere

Fred L. Whipple, ***Harvard College Observatory***

Clear evidence for horizontal winds generally exceeding those near the earth's surface is now available continuously to an altitude through the E-region. Much stronger winds have been detected in the F-regions of the ionosphere. The 12-hr solar tide clearly appears in the averaged E-region winds. Some progress is being made in establishing the general circulation patterns in the high atmosphere as a function of season and latitude.

The older observational techniques involving balloons and visual observations of persistent meteor trains, noctilucent clouds, and night-sky radiations have been augmented by a number of complex and precise techniques involving rockets, radio, radar, photoelectricity, and photography. The applications of these new techniques during the Geophysical Year should go far in establishing the world-wide circulation patterns in the high atmosphere. We may expect to increase vastly our understanding of the relationships among the motor sources for atmospheric motions, the ozone layer, the ionospheric layers, solar phenomena, terrestrial magnetism, and other of the many interrelated phenomena in the high atmosphere. Perhaps these observations will give us some clue to a dynamic coupling between the upper and the lower atmosphere, involving meteorology.

Particularly needed are techniques for measuring vertical motions at high levels in the atmosphere, to explain the thorough mixing now recognized to heights above the E-region.

Action of Alkali on *D*-Fructose

M. L. Wolfrom and J. N. Schumacher
Ohio State University

In an attempt to interpret in part the nature of the alkaline defecation process in cane sugar-house work, an aqueous solution 0.2*M* in *D*-fructose and 0.2*M* in aconitic acid was adjusted to *p*H 7.8 with potassium hydroxide and heated for 24 hr at 100° C; final *p*H 6.15. Excess *D*-fructose was removed by yeast fermentation from the deionized solution, and the sirup obtained on solvent removal was chromatagraphed on clay with 90 percent ethanol as developer. A crystalline mixture of *D,L*-sorbose + *D*-sorbose was isolated from the effluent, identification being made primarily by conversion to the alditols *D,L*-glucitol, *L*-glucitol, *D,L*-iditol, and *D*-iditol, identified as their crystalline hexa-acetates separated by fractional crystallization. The main zone from the clay column was further chromatographed on paper sheets (1-butanol, ethanol and water as developer) and a crystalline mixture was isolated which was separated and identified as *D,L*-allose + *D*-(or *L*) allose. Reduction of the crude zone material yielded galactitol (dulcitol) and allitol, identified as their crystalline hexa-acetates. These data are interpretable on the basis of interconversion through enediol intermediates accompanied by reverse aldolization followed by triose fragmentation recombination.

A Biochemical and Pharmacological Suggestion about Certain Mental Disorders

D. W. Woolley and E. Shaw
Rockefeller Institute for Medical Research

Recent findings in animals made in this laboratory and elsewhere have revealed that certain mental processes probably are mediated through the action of the hormone serotonin. This tentative conclusion is based on studies of a variety of antiserotonins. Thus, the ergot alkaloids, the harmala alkaloids, and yohimbine function in smooth-muscle preparations as antimetabolites of serotonin. These natural drugs are structurally related, each in a different way, to serotonin. Similarly, several synthetic analogs of the hormone have been prepared and likewise shown to act as antimetabolites of it. Among each of these classes of compounds are substances that cause mental aberrations. Thus, the ergot alkaloid derivative lysergic acid diethylamide, harmaline, yohimbine, and the synthetic antimetabolite called medmain are such representatives. The demonstrated ability of such agents to antagonize the action of serotonin in smooth muscle and the finding of

serotonin in the brain suggest that the mental changes caused by the drugs are the result of a serotonin-deficiency which they induce in the brain. If this be true, then the naturally occurring mental disorders—for example, schizophrenia—which are mimicked by these drugs, may be pictured as being the result of a cerebral serotonin deficiency arising from a metabolic failure rather than from drug action. Possibly, therefore, these natural mental disorders could be treated with serotonin.

Those professionally qualified for clinical experimentation are urged to apply these biochemical and pharmacological findings. Experiments in animals revealed that serotonin injected peripherally fails to penetrate the blood-brain barrier. Consequently, it is suggested that a serotonin-like compound which will penetrate to the desired site may be required.

News and Notes

Radio Astronomy Conference

A 3-day conference on radio astronomy, jointly sponsored by the National Science Foundation, the Carnegie Institution of Washington, and the California Institute of Technology, was held in Washington, January 4–6, 1954. The organizing committee of the conference consisted of Jesse L. Greenstein, chairman, Bart J. Bok, J. B. Wiesner, Merle A. Tuve, and John P. Hagen, secretary. A special fund was provided by the National Science Foundation for the conference. The conference was called to bring together some 75 astronomers, physicists, and electronic engineers to discuss the current status of research in this country and abroad, the nature of the problems in radio astronomy, and profitable directions for future work in this relatively new field, which has become a promising new method of attacking astronomical problems.

The group was welcomed by Lee DuBridge, of the California Institute of Technology, Paul A. Scherer, of the Carnegie Institution of Washington, and Raymond J. Seegar, of the National Science Foundation. Dr. Seegar, noting the international character of the gathering, called attention to the presence of distinguished visitors from other countries: H. Alfven, from Sweden; L. Owren, from Norway; B. Y. Mills and E. G. Bowen, from Australia; R. Hanbury-Brown, C. G. Little, F. Graham Smith, and F. Hoyle, from England; A. E. Covington, from Canada; H. C. van de Hulst, from the Netherlands; A. P. Mitra, from India. United States participants included representatives of leading universities, industrial and government laboratories.

Discrete sources of radio radiation of both galactic and extragalactic origin

B. Y. Mills presented the work of the Radio Physics Laboratory on the spectra, shapes and sizes of the stronger radio point sources. The intensity was shown to follow a law, $I = \lambda^n$, where $n = 1.7$ for three sources Cygnus A, Virgo A, and Centaurus, and $n = 0.7$ for Taurus. When the work at the longest wavelength, 16 m, was included, n was scattered with a grouping around $n = 1$ and $n = 2$. Interferometric measurement of the size and shape were made using two instruments with base lines at right angles to each other. The shapes were roughly oval with an angular size of 5′ to 10′. *R. Hanbury-Brown* continued the discussion with a description of the work at Manchester. Observation of those sources within the field of view of the 218-ft parabola (focal length 126 ft, $\lambda = 1.9$ m, which is a band on the celestial sphere bounded by the two latitude circles $+40°$ and $+70°$), shows that the intense sources seem to lie near the galactic plane. Among the sources seen in this strip are Cygnus X and one at the position of Tycho Brahe's supernova. A new type interferometer capable of operating at extremely long base lines and depending for its operation upon the correlation between the low-frequency components in the envelope of the signal was described. This instrument was used to measure the angular diameter of Cassiopeia and Cygnus A. Cassiopeia had a diameter of about 5′ of arc. Cygnus A, however, appeared asymmetrical. The simplest model fitting the observations consists of two objects 50″ × 30″ separated by 1′28″. Five of the discrete sources seen have been associated with extragalactic nebulae. In each case, the radio flux agrees with the light flux. Variations in the background radiation have been associated with aggregates of nebulae and with irregularities in their distribution.

C. G. Little, of Jodrell Bank, described the work on the measurement of ionospheric winds through the motion of meteor trails. He also pointed out that measurement of the winds through scintillation of radio stars has revealed that the ionospheric irregularities are about 4 km in size and have a predominantly westerly motion in the evening and easterly in the morning. *F. G. Smith* then discussed some of the work now in progress at Cambridge and described the new interferometer system consisting of four aerial systems, each 18,000 ft² in area, placed at the corners of a rectangle 1800 by 180 ft. With this system, a new source IC443 has been identified. Observation of the occultation of the Taurus source by the solar corona reveals that the radio waves are scattered by inhomogeneities in the corona out to 15 solar radii, indicating that the outer corona is more extensive and dense than thought previously. *F. T. Haddock,* of the Naval Research Laboratory, reported on the new measurements with the 50-ft radiotelescope at wavelength 9.4 cm. Radiation from several of the radio sources has now been measured at this short wavelength, thus extending the short-wave limit of the radio spectrum of the sources. Radiation from the Orion Nebula and other emission nebulae was measured for the first time.

G. Reber, of the Research Corporation, described his new installation on a mountaintop in Hawaii overlooking the short-wave limit of the radio spectrum of the height to obtain high resolution at long wavelengths in the measurement of the size, position, and intensity of the sources. Ionospheric effects are larger than anticipated and are being evaluated.

J. D. Kraus, of Ohio State University, presented some of the results obtained with the new antenna, an array of helices fixed in hour angle but capable of being trained in declination. The survey made with this antenna at 1.2 m wavelength has revealed many radio sources and, in addition, shows a background irregularity that can be associated with an irregularity in the distribution of extragalactic nebulae. *J. P. Hagen,* of the Naval Research Laboratory, described some of the results of solar research using the high resolution obtainable with the 50-ft antenna at centimeter and millimeter wavelengths and by using eclipse observations. Both the eclipse measurements at these wavelengths and the measurements with the high-resolution antenna at millimeter wavelength show limb brightening on the sun; this is in accordance with predictions of the earlier theory of the quiet sun. The 8-mm observations relating to radiation from deeper regions in the sun's atmosphere require an extension of the theory. The observations can best be explained by a two-fluid model of the chromosphere. *E. G. Bowen,* of Australia, reported that Christiansen, with two multiple-beam interferometers, has found that at a wavelength of 20 cm the sun appears asymmetrical with pronounced limb brightening along the E-W direction and no limb brightening in the N-S direction. Wild's spectrometer has been extended to cover the range 40 to 240 Mc/sec. Flare records can be interpreted to show particles emitted with velocities from 500 to 1000 km/sec. At the same time, the new records show particles with a velocity one-fifth to one-tenth the velocity of light. This latter result may have some bearing on the origin of the aurora and cosmic rays. *A. E. Covington,* of the National Research Council, Canada, gave a review of his measurement of the solar flux at 10-cm wavelength dating back to 1947. There is a strong correlation between the 10-cm enhanced radiation and sunspot activity. Bursts of radiation have been classified according to a system of a few terms. A 150-ft linear array having a 0.125° × 20° beam is now in use to locate radio sunspots. *C. R. Burrows* told of the work at Cornell University. He described the instruments available there and at Sacramento Peak, N.M., and their calibration. Combining pencil-beam and interferometer measurements, the workers at Cornell have shown that 200-Mc/sec bursts are in general elliptically polarized. Work relating to the polarization of bursts to position of origin on the sun is continuing.

Helen Dodson reported on two cooperative studies by the McMath-Hulbert Observatory with Dr. Burrows and Mr. Owren, of Cornell University, and with A. E. Covington, of solar radiation at 1.5 m and 10 cm at the time of solar flares. The studies showed that distinctive events at 1.5 m are more likely to be associated with flares than are events at 10 cm, 78 against 40 percent. On the other hand, flares with associated events at 10 cm are more likely to occur as the importance of the flare increases. At 1.5 m, the percentage of flares associated with radio events is independent of flare importance. Sudden ionospheric disturbances are more probable as the flare importance increases and are more probable when a 10-cm burst accompanies the flare. *H. C. van de Hulst,* commenting on the preceding papers, reported some work of Seegar, when at Cornell, where fast recordings of the 1.5-m signal from the sun were made. Recent examination of these records shows that small bursts associated with flares are longer (about 3 sec) than similar bursts occurring on "stormy" days. Also, major bursts associated with flares may have an associated small burst occurring as much as half an hour before the main event. *W. O. Roberts* discussed the relationship of spicules to the structure of the chromosphere and suggested that they also play a part in the formation of the corona. He pointed out that the larger rays and streamers in the corona are associated with plages and spots. Dense, hot material from flare regions diffuses with a velocity of 0.5 to 1 km/sec into the solar atmosphere. This can be a source of radio emission. *F. T. Haddock* reviewed the eclipse measurements in the centimeter region. He pointed out that the high resolution offered by an eclipse, coupled with the fact that the radio sun is little larger than the moon, makes such measurements ideal for studying the brightness distribution over the surface of the sun. The Naval Research Laboratory measurements at Khartoum, Sudan, show the effect of localized regions of enhanced emission and, when analyzed for radial brightness distribution, show the limb brightening predicted by theory.

Problems and theory in radio astronomy

R. Minkowski opened the subject of problems and theory with a progress report on astronomical observations of radio sources. Cygnus A, the strongest of the sources identified with peculiar extragalactic systems, is an 18th magnitude nebula consisting of two galaxies in collision. The radio emission appears to come from regions too faint to be seen visually, and the inference is that the radio emission comes from the interaction of the moving gas clouds, since most of the stars will not be affected by the collision. The galactic sources are of three types characterized by the following three sources: Cassiopeia, Crab Nebula, and IC443. Each of these is a mass of gas with high random internal motions. This, therefore, suggests a connection between random motions and radio emission with a suggestion that greater velocity spread is associated with greater radio emission. *Jesse L. Greenstein* discussed thermal emission from gases and some energy considerations in nonthermal sources. Radiation from H II regions, such as that in the Orion Nebula recently discovered at the Naval Research Laboratory, is related to the emission measure

$n_i\ n_e l$ (n_i, n_e per cm^3, l in parsecs). Isolated regions of small E.M. require high-resolution antennas, such as those obtained with the 50-ft Naval Research Laboratory radiotelescope used at 30-cm or shorter wavelength, for their detection and measurement. Calculation of the total energy available in the moving gas clouds of nonthermal sources shows that the energy emitted in the Cygnus source is only 5 percent of the total kinetic energy. Similar calculations have been made for Cassiopeia source. *F. Hoyle* continued the discussion of the strong radio sources and suggested synchrotron-type emission by relativistic electrons as a possible mechanism.

F. G. Smith discussed some of the pressing problems in radio astronomy. An understanding of the nature of the galactic and extragalactic backgrounds will require a study over a wide frequency range to determine the spectrum. This work needs to be supplemented by the use of high-resolution antennas. The mechanism of radiation in unusual bodies, such as the disturbed sun and radio stars, must be sought out. *Hari K. Sen* discussed his extension of the small-signal theory of noise generation by oscillating plasma to the nonlinear case. One success of this theory was to predict the presence of higher harmonics in the generated radiation; such an effect was observed by the Australian workers in burst radiation associated with solar flares.

Antenna and equipment problems

J. D. Kraus described the linear array of helical antennas used at Ohio State University at a wavelength of 1.2 m. This type of antenna is very convenient to work with, since little coupling exists between adjacent elements. The antenna has a further advantage over older linear array designs in that it is usable over a wide (approximately 2 to 1) range of wavelengths. *B. Y. Mills* discussed the method now being tried in Australia to obtain a pencil beam with low effective aperture. This is effected by connecting two linear arrays disposed at right angles to each other to the same receiver in such a way that only signals present in the two beams simultaneously register in the output. Discussion by Hanbury-Brown brought out the fact that such an arrangement augmented the effect of side lobes. *R. Hanbury-Brown* discussed the large paraboloid under construction at Jodrell Bank. The steerable paraboloid will have an aperture of 250 ft and focal length of 62.5 ft. The shortest usable wavelength will be determined by the surface tolerance, which cannot be stated with certainty yet. The possible use of the central portion of the dish at 20-cm wavelength was discussed. Partial operation is expected by 1955. *John P. Hagen* then described the high-resolution 50-ft reflector at the Naval Research Laboratory. This antenna differs from those previously discussed in that the solid surface is accurately machined to allow its use at wavelengths as short as 8 mm, where the beam width is 3′ of arc. The use of high resolution in studying the brightness distribution of the sun and moon was discussed.

In an informal discussion of the relative merits of various means of constructing large antennas, led by *E. G. Bowen,* it was the consensus that future work in radio astronomy will require the use of the largest antennas feasible. Bowen proposed and illustrated a method of mounting a large paraboloid by securing it to a sphere which is then floated in a shallow pool of water. This method of mounting should reduce the total weight of the structure by a factor of 3 or 4.

H. I. Ewen described the new 21-cm radiometer equipment now in use at Harvard with a 25-ft paraboloid; this equipment differs from earlier models in that the signal at the hydrogen-line frequency is continuously compared with the noise signal in a comparison band displaced a few megacycles. *C. G. Little* described the Manchester 21-cm receiver, which uses a 30-ft paraboloid; the receiver is of the switching type but uses two IF channels separated in frequency by 1 Mc/sec, thereby making it possible to observe the signal full time and also to suppress interference. *H. Tatel* described the equipment in use and under construction at the Carnegie Institution of Washington. The present equipment is used with a signal band width somewhat narrower than that used by the Dutch. The higher resolution obtained is shown by deeper minima in the frequency sweeps.

N. T. Lavoo, of the General Electric Company, discussed amplifier tubes suitable for use at the short wavelengths used in radio astronomy. Modern close-spaced triode amplifiers, such as the L-29, when used in the input circuits of IF amplifiers reduce the noise figure to 0.3 db, thus helping to reduce the over-all noise figure of the receiver. The tubes can also be used effectively as amplifiers at signal frequency for all but the shortest (centimeter and decimeter) wavelengths. *Cornell H. Mayer,* of the Naval Research Laboratory, described a method of improving the ability of a radiometer to measure small noise powers through the use of ferrite elements adjusted for unidirectional transmission. In this way, the deleterious effects of variations in input impedance are minimized. A radiometer using a ferrite element as a chopper was described with an improvement of a factor of 50 over a conventional rotating disk chopper.

Galactic research

H. C. van de Hulst described the Dutch work. There is some effort being put on solar observations at 1.5 and 2 m. Work is under way to complete a survey of galactic radiation at 75 cm to bring Reber's early survey up to date. The 21-cm hydrogen-line survey has continued with an attempt to better estimate the center frequency, to correct the observations for antenna pattern, and to come to a better estimate of temperature by correcting for saturation and for the continuous background. New work on the extension of the spiral arms into the region inside the sun's orbit was described. *C. H. Townes,* of Columbia University, discussed line spectra in the microwave region of atoms and molecules of astrophysical interest. In addition to the known 21-cm line, there are several lines that fall in an available part of the spectrum. The most prom-

ising of these would seem to be the OH line in the neighborhood of 18 cm wavelength. *B. Y. Mills* reported on the observation of radio radiation from the Magellanic Clouds both at 3-m wavelength and in the line radiation from neutral hydrogen at 21 cm. The ratio of gas to dust is found to be very different in the two systems, being higher for the smaller cloud. The hydrogen-line measurements also showed a motion of rotation of the two as a binary system combined with a translation.

R. H. Dicke, of Princeton University, described the mechanism for the 21-cm line emission and showed that collision cross sections are such that collision caused by the thermal motion of the hydrogen atoms is responsible for the excitation of the radiation and that there is a consequent equilibrium with the kinetic temperature of the gas. *B. J. Bok* then described the work at Harvard using the 21-cm equipment described earlier by Ewen. Regional surveys of the galactic center and anticenter are being conducted first. In the direction of the center, a secondary maximum at 20° north galactic latitude was found, and in the direction of the anticenter a similar extension to the south of the plane of the galaxy appeared. These secondary maxima are associated with the positions of the Ophiucus and Taurus dark nebulae regions.

The conference closed with a discussion of special topics. Solar research and the generation and amplification of radio noise in plasmas and electron streams were the topics of most interest.

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Science News

Nearly a third of the December issue of *Arctic*, recently published by The Arctic Institute of North America, is devoted to "A preliminary field report" of the **Baffin Island Expedition, 1953.** This is the first scientific report of the findings of this important venture which last summer brought a diverse group of specialists to the study of the Cumberland Peninsula, until then largely a scientific blank. The enormity of the effort and the hazards involved in the undertaking, to which one of the scientists sacrificed his life, are suggested in the reports presented by various members of the party and covering studies in glaciology, meteorology, geology, geomorphology, zoology, and botany, and also mountaineering, surveying, and photography. Expedition leader was Patrick D. Baird, glaciologist, former winner of the Founder's Medal of the Royal Geographical Society and director of the Arctic Institute's Montreal Office.

A prime objective of the 13-man team was study of the Penny Icecap in order to improve understanding of the physics of ice-masses and their relation to weather patterns, water supply, and long-range climatic changes. A camp was established on May 16 on the highest dome of this 20-by-90 mi ice sheet lying 1¼ mi above sea level. Later investigations carried members of the party the full length of one of its typical outflowing glaciers. Although the "ablation" or melting season at the head of this glacier lasted a total of only 190 hr, an extraordinarily high ablation rate in the lower reaches is reported by W. H. Ward, English glaciologist, who writes that up to 7 ft of the original ice in the terminal region had melted away by the end of August. At the height of the ablation season, amid "atrocious" conditions for walking and transportation, 1000 ft of telephone cable used in connection with seismic measurements of ice thickness was swept away by the sudden outbreak of a meltstream.

Measurements of the movement of the glacier, which showed flowage rates of from 10 to 52 ft in a little over a month, were confirmed by observation of the rate at which "crevasses visibly opened and closed around one of our tents on the glacier." A further hazard was caused by fog which at the highest icecap station occurred on 25 days in June, 27 in July, and 8 of the first 9 days of August.

The spectacular nature of the terrain is indicated by Ward who describes ice cliffs atop "3000-foot-high rock walls which form the troughs of the valley glaciers." D. J. Kidd, Canadian geologist, refers to "hanging valleys" carved out by numerous glaciers. Dr. Kidd reports that rocks of volcanic origin exist for 55 mi along the Cumberland Peninsula Coast and suggests that the land mass they represent has risen 800–1400 ft above sea level since its formation. Geologists have long speculated on whether the "belt" of Tertiary volcanic rocks which extends from Scotland through Iceland to eastern and western Greenland can also be found in Baffin Island.

Zoological investigations are reported by A. Watson of McGill University, who conducted a special study of the breeding biology and behavior of a colony of snowy owls from incubation time until the young could fly. A continuous record was kept of hatching, food, and growth rates of the young, a study which resulted in "aggressive and often distraction behavior" on the part of the adult owls whose reactions became markedly confused by the necessary invasion of the nests. Botanical studies are reported by F. H. Schwarzenbach, one of four representatives of the Foundation for Swiss Alpine Research who took part in the expedition.

Eight peaks up to 7000 ft were scaled by members of the expedition between periods of scientific work. One of these, Mt. Battle, was named for W. R. B. Battle, young geomorphologist of McGill University whose tragic death by drowning in a glacial stream occurred in mid-July. Sixteen additional place names bestowed by members of the Arctic Institute party have been approved by the Canadian Board on Geographical Names. Among them are Coronation Fiord and Coronation Glacier, first reconnoitered on the day Queen Elizabeth was crowned.

The **World Health Organization** has issued a report for 1953 that reveals WHO's widening responsibilities

in fighting epidemics, improving sanitation, and promoting maternal and child health. Aid was furnished to 74 countries, involving 330 projects of which 106 were completed in 1953. Main efforts were directed against malaria, yaws, venereal infections, and tuberculosis.

"Off with their heads" was the title of this editorial in *The Washington Post-Times Herald* for April 17:

Secretary Wilson seems to consider himself competent to carry on the scientific research work of the Defense Department all by himself. As though geniuses were a dime a dozen, he indicated the other day that he will not utilize the services of Dr. J. Robert Oppenheimer for the Defense Department regardless of the decision of the Atomic Energy Commission board now considering security risk charges against the physicist. Mr. Wilson said he had "the greatest sympathy for any one who made a mistake and reformed." And then he added: "I think they ought to be reformed somewhere else than in the military services."

There is reflected in this not only a calloused prejudgment of the case, but also an appalling ignorance concerning the relation of science to security. . . . The point is that scientists of Dr. Oppenheimer's brilliance and experience are altogether too rare in this country. Only a small handful of men share his practical knowledge of nuclear physics. If he is cleared by the Security Board, he has a unique contribution to make to the national defense. The clearance ought to be complete—and without the narrow qualification Mr. Wilson would so patronizingly attach to it.

And on the same page, the following item appeared under the heading "Signpost":

At the Nurnberg trials in Germany, the following exchange took place between Supreme Court Justice Robert H. Jackson, then chief of counsel for the United States, and Albert Speer, Reich Minister for Armament and Munitions:

Q. And certain experiments were also conducted and research conducted in atomic energy, were they not?

A. Unfortunately, because our best experts we had in atom research had gone to America, we hadn't advanced as far as we wanted to. We suffered setbacks in atom research and actually we were about one to two years from achieving results—the results of splitting the atom.

Q. The policy of driving people out who didn't agree with Germany hasn't produced very good dividends, has it?

A. That, as far as we were concerned, had a very decisive disadvantage particularly in this sector.

Scientists in the News

Harriet Allen, professor of physics at Western College for Women, Oxford, Ohio, has commenced a 3-yr leave of absence to serve as visiting professor at the American College for Girls in Arnavutkoy, Istanbul, Turkey, where she is teaching mathematics and physics.

Six engineers and industrialists will be cited for outstanding accomplishment at the annual University of Wisconsin Engineers Day celebration on May 7. Those to be honored are:

Arne J. Asplund, president of the Defibrator Corp., Stockholm, Sweden.

Adolph J. Ackerman, consulting engineer, Madison.

Mack C. Lake, formerly president and now consultant of the Orinoco Mining Co., New York.

David W. McLenegan, manager of technical personnel and education at the Hanford Atomic Products Operation of the General Electric Co., Richland, Wash.

Robert C. Siegel, chief engineer of the Wisconsin Telephone Co., Milwaukee.

John Slezak, undersecretary of the Army, Washington, D.C.

Walter Baade is to receive the Gold Medal of the Royal Astronomical Society, its highest honor, "for his observational work on galactic and extra-galactic objects." He is a staff member of the Mount Wilson and Palomar Observatories, which are jointly operated by the Carnegie Institution of Washington and the California Institute of Technology.

Dr. Baade has also been appointed to the honorary Charles M. and Martha Hitchcock professorship at the University of California. In this capacity he will be in residence at Berkeley during the month of May and will deliver a series of public lectures, "Galaxies, their composition and evolution."

Firman E. Bear, since 1940 professor of agricultural chemistry and chairman of the Soils Department at the New Jersey Agricultural Experiment Station, Rutgers University, will retire on June 30. He will be succeeded by **Russel B. Alderfer,** professor of soil technology at Pennsylvania State University. Dr. Bear will continue as editor-in-chief of *Soil Science* and will maintain an office on the campus. Immediately following his retirement, he will spend some time in South America, stopping in Peru, Chile, Argentina, and Brazil.

Dr. Bear received the B.S. and M.S. degrees from Ohio State University, where he specialized in agricultural and general chemistry. The University of Wisconsin later awarded him a Ph.D. after he had completed investigations in bacteriology, biological chemistry, and soils. He was instructor in soils at Ohio State University from 1908 to 1910, and he lectured at over-the-state schools for farmers in Ohio from 1910 to 1912, before the days of the now familiar county agent. After an interval as head of the soils department at the University of West Virginia, he returned to Ohio State as head of the Department of Soils, which position he held from 1916 to 1929.

From 1929 to 1938, as director of agricultural research for the American Cyanamid Company, Dr. Bear traveled throughout the United States, over much of Europe, and in Canada, Mexico, and Central America. For 2 yr, before his appointment to Rutgers, he was science editor of *Country Home Magazine.* He has been in constant demand as a speaker

at meetings of scientific and business organizations throughout the United States.

Dr. Bear is past president and fellow of the American Society of Agronomy, past president of the Soil Science Society of America, past president and fellow of the Soil Conservation Society of America, past vice-president of Section O and fellow, AAAS, and past chairman of the National Joint Committee on Grassland Agriculture. He is the author or coauthor of five books and of many bulletins, circulars, and journal articles, both scientific and popular. Many of this country's best known soil scientists have taken their advanced degrees with Dr. Bear or have worked under his direction.

John R. Bowman, who has been head of the Mellon Institute's Department of Research in Physical Chemistry and is also a member of the executive staff since 1948, is now a director of research. The Department of Physical Measurements has been united with the Department of Research in Physical Chemistry, with **Charles B. Willingham** as the head.

At the 91st annual meeting of the National Academy of Sciences the following awards were made:

To **Vannevar Bush,** president of the Carnegie Institution of Washington, the John J. Carty Medal for noteworthy and distinguished accomplishment. The Carty Fund committee stated: "Very few men in the history of our country have exerted so profound and so diversified an influence on science and its ramifications in our society. . . ."

To **William Shockley** of the Bell Telephone Laboratories, the $400 Comstock Prize "for his pioneering investigations and exposition of electric and magnetic properties of solid materials; in particular for his researches in the conduction of electricity by electrons and holes in semiconductors."

To **Raymond Carroll Osburn,** emeritus professor of zoology at the Ohio State University, the Daniel Giraud Elliot Medal for his publication *Bryozoa of the Pacific Coast of America.*

To **Alan Gregg,** vice president of the Rockefeller Foundation, the Public Welfare Medal " . . . to mark the appreciation of the National Academy for eminent service to the public, performed without a view to great monetary gains and by methods which, in the opinion of the Academy, are truly scientific."

Daniel C. Darrow, professor of pediatrics at Yale University School of Medicine, has accepted appointment to a newly created chair, the Children's Mercy Hospital professorship, in the Department of Pediatrics at the University of Kansas School of Medicine. The appointment becomes effective on July 1.

Cora Du Bois, anthropologist and director of research for the Institute of International Education at Washington, D.C., has been appointed by Harvard University and Radcliffe College to the Samuel Zemurray Jr. and Doris Zemurray Stone-Radcliffe professorship, effective July 1. The professorship is open to an outstanding woman scholar who may represent any field of learning. Dr. Du Bois, an authority on cross-cultural studies in personality, is known especially for her studies of California Indians and of the peoples of Indonesia and South Asia. Since 1951 she has been conducting research on student exchange programs and now is writing a book on the foreign student in the United States.

Kathryn Helm, a former captain in the Army Nurse Corps, has been appointed director of the School of Nursing and Nursing Service at St. Luke's Hospital, New York City.

Victor K. La Mer has returned to his teaching duties in the Chemistry Department of Columbia University after a sabbatical leave spent as guest professor at the University of Copenhagen, where he was supported by a Fulbright lectureship. The subject of his lectures was "Light scattering and colloid science." Prof. La Mer is editor-in-chief of the *Journal of Colloid Science.*

On April 16 **John B. Lucke,** professor of geology at The University of Connecticut, assumed the office of director of the Connecticut Geological and Natural History Survey; he succeeds **Edward L. Troxell,** who is retiring. Communications for Prof. Lucke should be addressed to him at the University of Connecticut.

A. C. McGuinness, dean of the University of Pennsylvania Graduate School of Medicine, has announced that he will leave his post to become clinical consultant for 10 hospitals being built by the United Mine Workers Welfare and Retirement Fund.

Harold Schlosberg has been appointed chairman of the Department of Psychology at Brown University as of Mar. 22, the 65th birthday of **Walter S. Hunter,** chairman of the department since 1936. Prof. Hunter will continue as an active member of the staff.

In the Laboratories

The **Commonwealth Scientific and Industrial Research Organization's Section of Methametical Statistics,** which has headquarters in Adelaide, Australia, has now become the Division of Mathematical Statistics E. A. Cornish, is chief of the new division, which will provide research workers with special help in planning their projects and analyzing and interpreting their experimental results.

The **Du Pont Company** has dedicated a $2,000,000 structure that will provide enlarged facilities for the company's **Haskell Laboratory for Toxicology** and **Industrial Medicine** which since its establishment in 1935 has been in operation at the Experimental Station in Wilmington. The new Haskell Laboratory is a single-story, air-conditioned building of 33,000 ft^2, situated near Newark, Del., about 17 mi from Wilmington. Originally the laboratory was established to test Du

Pont products and manufacturing processes to eliminate as far as possible every potential health hazard to employees and customers. Its activities have expanded to include broad studies in toxicology, biochemistry, pathology, physics, and physiology. Today the research staff is searching for basic knowledge of the causes and effects of fatigue, factors that make clothing comfortable, and methods for the early determination of abnormal heart conditions, as well as investigating the toxicity of chemicals made or used by the company.

The **General Electric Company,** Schenectady, N.Y., recently held a ground breaking ceremony in Waynesboro, Va., for a new plant that will manufacture electronic controls for industrial and aviation use. Expected to be in full operation sometime next year, the plant will employ about 550 people. Facilities on the 70-acre site will include a large manufacturing area, warehouse, laboratory, personnel facilities, and offices.

The first linear accelerator built for medical purposes and intended for cancer research and therapy with fast electrons has been installed at the **Michael Reese Hospital** in Chicago. It was constructed by Helene Curtis Industries, Inc., of Chicago, on the pattern of the Stanford University units developed in the Palo Alto Microwave Laboratory, and has a maximum capacity of 45 mev. The klystron, accelerator tube, electron gun, and pulse transformer were built at Stanford University.

The accelerator is housed in a reinforced concrete building with walls 3 ft thick. The instrument itself is separated from the patients' treatment room, and this in turn is separated from the control room. The 10-ft-long tube is suspended from the ceiling 7 ft above ground level and terminates in a window between the machine and the treatment room. Two magnets are to be installed for directing the electron beam and for swinging the beam in a 90° arc from the vertical line. Experiments on biological objects will be started by July 1.

The project, which involves the expenditure of approximately $250,000 entirely financed by private donations, is under the direction of Erich M. Uhlmann, director of the hospital, and Charles Hsieh, chief physicist of the Tumor Clinic.

Increased effectiveness is expected to result from the recent reorganization of the research department of the **Naval Research Laboratory,** Washington, D.C. The reorganization, the first major one since the end of World War II, was based on the recommendations of a team of three NRL scientists. Their report was made after a 6-mo study of the Laboratory's scientific organization and program-planning, and after supplemental visits to other Government and industrial research laboratories.

As before, the research department is headed by a director of research, E. O. Hulburt. Under the new plan, he has three associates, one each in the fields of electronics, materials, and nucleonics; they are R. M. Page, O. T. Marzke, and E. H. Krause, respectively. There are now 13, instead of 12, scientific divisions which conduct research, development, and evaluation work in the physical sciences. The names of these divisions suggest the scope of the laboratory's scientific program: Applications Research; Atmosphere and Astrophysics; Chemistry; Electronics; Mechanics; Metallurgy; Nucleonics; Optics; Radar; Radiation; Radio; Solid State; and Sound. New superintendents and their divisions are: R. C. Guthrie, Radar; J. P. Hagen, Atmosphere and Astrophysics; W. S. Pellini, Metallurgy; A. H. Schooley, Electronics; and C. V. Strain, Nucleonics.

The **New Jersey Zinc Company** has contracted to buy the Gloucester City, N.J., titanium dioxide plant of the American Cyanamid Company.

The **Stanford Research Institute,** Stanford, Calif., is starting the operation of its new Pacific Northwest Division with the establishment of an office in Portland, Ore. Through this office, the Institute expects to launch a research program on problems connected with the long-range development of power and water resources of the Pacific Northwest, working closely with other groups and interests in the area.

The **Will Corporation** of Rochester, N.Y., has announced two name changes. Its Atlanta laboratory supply house is to be called the Will Corporation of Georgia instead of Southern Scientific Co., Inc., and the Buffalo Apparatus Corporation will be Will-Buffalo, Inc. Ownership, services, and personnel remain the same in both places.

Grants and Fellowships

The **Brooklyn Botanic Garden** has announced a gift to endowment of $100,000 from the estate of the late Anna L. Hills.

Ciba Pharmaceutical Products, Inc., Summit, N.J., awarded the following research grants during March:

New York University-Bellevue Medical Center. C. Rein, Dept. of Clinical Dermatology and Syphilology.
New York University College of Medicine. H. S. Kupperman, Dept. of Therapeutics.
University of California, Los Angeles. T. A. Geissman, Dept. of Chemistry.
University of Southern California School of Medicine. D. M. Green, Hypertension Clinic.
Northwestern University School of Medicine. E. C. Texter, Jr., Dept. of Medicine.
Jewish Hospital, St. Louis, Mo. M. Alex.
University of California, San Francisco. T. L. Althausen, Dept. of Medicine.
University of Utah School of Medicine. L. S. Goodman, Dept. of Pharmacology.

The **National Science Foundation** has announced the award of 657 predoctoral graduate fellowships in the natural sciences to United States citizens for the year 1954–55. Successful fellows were selected from 2865 applicants from all parts of the continental United States, Alaska, Hawaii, and Puerto Rico. In addition,

1355 applicants were accorded honorable mention. A list of fellowship recipients follows:

Alabama

R. R. Odom, Fairfield; Birmingham-Southern Coll., Chem.
C. M. Steinberg, Montgomery; Vanderbilt U., Biophys.
P. Toulmin, Birmingham; Harvard U., Earth Sci.

Arizona

D. G. Bryant, Tuscon; U. of Arizona, Earth Sci.
B. D. Bucher, Phoenix; Princeton U., Math.

Arkansas

J. F. Hays, Little Rock; Columbia U., Earth Sci.

California

D. L. Abell, Fresno; U. of California, Zool.
E. M. Acton, Morgan Hill; Massachusetts Inst. of Tech., Chem.
D. E. Applequist, Berkeley; California Inst. of Tech., Chem.
J. B. Applequist, Berkeley; U. of California, Chem.
G. A. Baker, Jr., Davis; California Inst. of Tech., Phys.
A. M. Barnes, Richmond; San Diego St. Coll., Zool.
E. D. Becker, Berkeley; U. of California, Chem.
D. R. Bennion, Los Altos; Stanford U., Eng.
I. S. Bjorklund, Los Angeles; Stanford U., Eng.
A. T. Bottini, Petaluma; U. of California, Chem.
J. D. Britton, Los Angeles; California Inst. of Tech., Chem.
M. E. Browne, Long Beach; U. of California, Phys.
D. L. Bunker, Simi; California Inst. of Tech., Chem.
S. J. Carlquist, San Marino; U. of California, Bot.
J. A. Carlson, Pasadena; California Inst. of Tech., Eng.
M. Cher, Los Angeles; California Inst. of Tech., Chem.
J. W. Crump, Sebastopol; U. of Illinois, Chem.
N. H. De Nevers, San Francisco; Stanford U., Eng.
W. E. Dibble, Glendale; California Inst. of Tech., Biophys.
L. R. Doherty, San Diego; U. of Michigan, Phys.
W. J. Downhower, Altadena; Stanford U., Eng.
R. L. Dressler, Inglewood; Harvard U., Bot.
W. P. Eatherly, Temple City; U. of South. California, Phys.
S. D. Elliott, Jr., Independence; Yale U., Phys.
R. Fuchs, Altadena; California Inst. of Tech., Phys.
R. H. Good, Berkeley; U. of California, Phys.
A. L. Gram, III, San Marino; U. of California, Eng.
B. Harris, Arcadia; Yale U., Math.
B. J. Hartz, Albany; U. of California, Eng.
R. S. Hoffmann, Albany; U. of California, Zool.
C. A. Hopson, Mill Valley; Johns Hopkins U., Earth Sci.
M. L. Houston, San Francisco; U. of California, Zool.
C. D. Joel, Vista; Harvard U., Biochem.
R. E. Jones, Watsonville; M.I.T., Eng.
G. H. Keitel, Palo Alto; Stanford U., Eng.
J. H. Kennedy, Los Angeles; U. of California, Chem.
R. P. Kraft, Albany; U. of California, Phys.
R. E. Levin, Santa Ana; Stanford U., Eng.
J. C. Little, Stockton; U. of California, Chem.
J. Mathews, Sierra Madre; California Inst. of Tech., Phys.
D. S. Matteson, Berkeley; U. of California, Chem.
E. A. Meyer, Berkeley; Johns Hopkins U., Microbiol.
J. C. Mitchell, Van Nuys; California Inst. of Tech., Chem.
J. D. Mohler, Berkeley; U. of California, Gen.
J. E. Monson, Palo Alto; Stanford U., Eng.
L. N. Morrisett, Jr., Los Angeles; Yale U., Psych.
A. Parducci, Berkeley; U. of California, Psych.
P. M. Ray, Saratoga; Harvard U., Bot.
W. B. Ray, Saratoga; California Inst. of Tech., Earth Sci.
R. A. Reeves, Los Angeles; U. of California, Chem.
J. H. Richards, Berkeley; U. of California, Chem.
L. W. Richards, Riverside; California Inst. of Tech., Chem.
K. W. Robinson, Los Angeles; Princeton U., Phys.
W. N. Runquist, Green Valley Lake; Northwestern U., Psych.
J. Sandweiss, Berkeley; U. of California, Phys.
R. L. Shreve, Bishop; California Inst. of Tech., Earth Sci.
J. W. Sidman, Berkeley; U. of California, Chem.
H. K. Sinclair, Los Angeles; U. of California, Chem.
F. T. Smith, San Francisco; Harvard U., Chem.
R. D. Smith, Oakland; M.I.T., Chem.
E. A. Stern, Los Angeles; California Inst. of Tech., Phys.
R. W. Tankersley, Jr., Stanford; Stanford U., Microbiol.
R. B. Taylor, Claremont; U. of Minnesota, Earth Sci.
J. B. Thomas, Stanford; Stanford U., Eng.
W. R. Thorson, Los Angeles; California Inst. of Tech., Chem.
E. O. Thorp, Los Angeles; U. of California, Phys.
W. M. Walsh, Los Angeles; Harvard U., Phys.
H. Weitzner, San Francisco; U. of California, Phys.
A. E. Wennstrom, Los Angeles; M.I.T., Eng.

Colorado

A. Benson, Boulder; U. of Colorado, Zool.
A. Danti, Colorado Springs; Colorado Coll., Chem.
R. C. Gunning, Longmont; Princeton U., Math.
V. C. Kennedy, Denver; U. of Colorado, Earth Sci.
F. B. Knight, Fort Collins; Duke U., Agri.
J. A. Laswick, Boulder; U. of Colorado, Chem.
J. R. Nazy, Denver; Regis College, Chem.
L. T. Reynolds, Denver; Harvard U., Chem.

Connecticut

N. C. Blais, New Haven; Yale U., Phys.
F. G. Carey, Rockville; Coll. of William & Mary, Zool.
W. T. Doyle, New Haven; Yale U., Phys.
G. B. Field, Pomfret; Princeton U., Phys.
D. L. Gilman, Storrs; M.I.T., Earth Sci.
C. L. Kilbourne, Woodmont; Brown U., Chem.
F. B. Mallory, New Haven; Yale U., Chem.
H. D. Peck, Jr., Middletown; Western Reserve U., Microbiol.
W. R. Reitman, Middletown; Wesleyan U., Psych.
M. F. Singer, New Haven; Yale U., Biochem.
W. G. Tifft, Seymour; Harvard U., Phys.
J. V. Trumbull, Stonington; U. of Connecticut, Earth Sci.
C. F. Wilcox, Cos Cob; U. of California, Chem.

District of Columbia

T. A. Farley, Washington; George Washington U., Phys.
R. B. Kellogg, Washington; U. of Chicago, Math.
F. L. Lambert, Washington; Harvard U., Zool.
P. C. Reynolds, Washington; Trinity Coll., Chem.
L. B. Schlegel, Washington; U. of Maryland, Math.
J. Spanier, Washington; U. of Chicago, Math.

Florida

H. C. Curl, Tallahassee; Florida St. U., Gen. Biol.
D. J. Foulis, South Miami; Tulane U., Math.
I. M. Klem, Miami; U. of North Carolina, Microbiol.
A. R. Marshall, Miami; U. of Miami, Gen. Biol.
R. D. McWilliams, Fort Myers; U. of Tennessee, Math.
W. A. Moser, Bradenton; Vanderbilt U., Phys.
R. C. C. Pilger, W. Palm Beach; U. of Notre Dame, Chem.
R. S. Silas, Gainesville; U. of Florida, Chem.

Georgia

W. A. Hagins, Oliver; Cambridge U., Med. Sci.
Z. Levine, Savannah; Georgia Inst. of Tech., Eng.
A. H. Neal, Atlanta; Emory U., Chem.

Illinois

J. S. Aagaard, Chicago; Northwestern U., Eng.
G. E. Backus, Chicago; U. of Chicago, Phys.
R. E. Baron, Chicago; U. of Chicago, Phys.
C. E. Barr, Elmwood Park; Iowa St. Coll., Bot.
W. S. Bartky, Chicago; Illinois Inst. of Tech., Math.
A. H. Cromer, Chicago; U. of Wisconsin, Phys.
D. D. Davis, Salem; U. of Minnesota, Chem.
D. H. Ezekiel, Urbana; U. of Illinois, Microbiol.
R. W. Fulmer, Champaign; U. of Illinois, Chem.
D. S. Gage, Palatine; Stanford U., Eng.
R. B. Garland, Elgin; M.I.T., Chem.
D. M. Geller, Oak Park; Harvard U., Biochem.
J. W. Gewartowski, Chicago; Stanford U., Eng.
R. W. Glade, Urbana; U. of Illinois, Zool.
R. D. Hamilton, Colfax; U. of Detroit, Microbiol.
R. Harder, Jr., Gibson City; U. of Illinois, Chem.
R. H. Hardin, Champaign; U. of Illinois, Eng.
H. D. Hartzler, Downers Grove; U. of Chicago, Chem.
A. Heller, Chicago; U. of Chicago, Med. Sci.
D. R. Hoff, Galesburg; M.I.T., Chem.
D. L. Johnson, Monmouth; Purdue U., Eng.
G. J. Kacek, Jr., Berwin; Illinois Inst. of Tech., Eng.
M. V. Klein, Highland Park; Northwestern U., Phys.
A. A. Krawetz, Evanston; U. of Chicago, Chem.
J. H. Law, Jr., Park Forest; U. of Illinois, Biochem.
S. Lederberg, Urbana; U. of Illinois, Microbiol.
A. D. Liehr, Chicago; Harvard U., Phys.
T. D. Little, Marissa; USAF Inst. of Tech., Eng.
H. M. Loux, St. Joseph; U. of Illinois, Chem.
L. W. Mednick, Chicago; U. of Chicago, Anthrop.
R. L. Metzenberg, Highland Park; California Inst. of Tech., Biochem.
R. L. Mieher, Waverly; U. of Illinois, Eng.
F. P. Peterson, Naperville; Princeton U., Math.
W. J. Peterson, Chicago; U. of Pennsylvania, Zool.
L. I. Rebhun, Chicago; U. of Chicago, Biochem.

F. Scardiglia, Chicago; U. of Illinois, Chem.
T. D. Schultz, Glencoe; M.I.T., Phys.
J. I. Simon, Wheaton; Northwestern U., Chem.
D. A. Speer, Morton Grove; U. of California, Chem.
E. O. Stejskal, Berwyn; U. of Illinois, Chem.
R. A. Swanson, Chicago; U. of Chicago, Phys.
R. S. Thomas, Champaign; U. of California, Biochem.
H. R. Waite, Chicago; Northwestern U., Chem.
J. W. Wilt, Chicago; U. of Chicago, Chem.
J. W. Winchester, Western Springs; M.I.T., Chem.

Indiana

I. G. Carroll, W. Lafayette; Purdue U., Microbiol.
J. P. Chesick, New Castle; Purdue U., Chem.
W. W. Cleland, Bloomington; U. of Wisconsin, Biochem.
W. R. Frazer, Indianapolis; Carleton Coll., Phys.
R. E. Gerkin, South Bend; U. of Chicago, Chem.
T. M. Hallman, W. Lafayette; Purdue U., Eng.
J. D. Harris, West Lafayette; Purdue U., Biophys.
J. B. Hemwall, West Lafayette; Purdue U., Agri.
M. M. Hiatt, Indianapolis; Hanover Coll., Microbiol.
L. M. Horger, W. Lafayette; Purdue U., Zool.
K. A. Johnson, Hobart; Harvard U., Phys.
J. J. Jones, Indianapolis; U. of Wisconsin, Bot.
R. P. Kaiser, South Bend; Purdue U., Eng.
W. C. Lordan, Gary; Wesleyan U., Math.
D. J. Mason, Cutler; Purdue U., Microbiol.
T. R. Mertens, St. Joe; Purdue U., Gen.
D. J. Meschi, Hammond; U. of California, Chem.
J. P. Mutschlecner, Fort Wayne; Indiana U., Phys.
M. E. Senko, Crown Point; U. of California, Chem.
W. D. Shephard, Gary; Wesleyan U., Phys.
F. S. Stephens, Wabash; U. of California, Chem.
T. L. Swihart, Elkhart; U. of Chicago, Phys.

Iowa

J. R. Anderson, Ames; Iowa St. Coll., Phys.
G. E. Collins, Adel; Cornell U., Math.
S. E. Darden, Sioux City; U. of Wisconsin, Phys.
D. H. Hug, Davenport; Iowa St. Coll., Microbiol.
J. S. Hyde, Des Moines; M.I.T., Phys.
C. G. King, Jr., Cedar Rapids; St. U. of Iowa, Eng.
B. O. Nolf, Iowa City; St. U. of Iowa, Earth Sci.
W. D. Ohlsen, Ames; Iowa St. Coll., Phys.
J. F. Pauls, Washington; Iowa St. Coll., Math.
L. M. Roth, Waterloo; Radcliffe Coll., Phys.
W. W. Rozeboom, Ottumwa; U. of Chicago, Psych.
R. M. Sanders, Waterloo; U. of Wisconsin, Phys.
R. L. Sass, Davenport; Augustana Coll., Chem.
C. F. Schumacher, Ames; Iowa St. Coll., Psych.
T. E. Stevens, Ames; Iowa St. Coll., Chem.
H. D. Young, Osage; Carnegie Inst. of Tech., Phys.

Kansas

N. P. Baumann, Sylvan Grove; U. of Kansas, Phys.
R. R. Brownlee, Zenith; Indiana U., Phys.
T. M. Burford, Wichita; U. of Wisconsin, Eng.
R. H. Capps, Wichita; U. of Wisconsin, Phys.
H. B. Hamilton, Wichita; U. of Oklahoma, Eng.
E. D. Hornbaker, Louisburg; U. of Virginia, Chem.
F. E. Ladd, Jr., Lawrence; U. of Kansas, Psych.
A. J. Lundeen, Fowler; Southwestern Coll., Chem.
F. W. Prosser, Lawrence; U. of Kansas, Phys.
R. W. Rydjord, Wichita; Municipal U. of Wichita, Psych.
R. L. Shaffer, Kinsley; Cornell U., Bot.

Kentucky

J. W. Cable, Murray; Florida St. U., Chem.
A. S. Horowitz, Ashland; Ohio St. U., Earth Sci.
W. W. Hunt, Franklin; Ohio St. U., Chem.

Louisiana

P. J. Beaver, New Orleans; Newcomb Coll., Microbiol.
P. E. Conner, Lafayette; Princeton U., Math.
R. E. Weaver, New Orleans; Tulane U., Eng.

Maine

R. A. Deering, Brooks; U. of Maine, Biophys.
D. B. Stewart, East Sumner; Harvard U., Earth Sci.

Maryland

R. W. Bass, Baltimore; Johns Hopkins U., Math.
F. D. Bedard, Baltimore; Johns Hopkins U., Phys.
A. L. Berman, Baltimore; Johns Hopkins U., Zool.
P. A. Cook, Baltimore; Princeton U., Eng.
A. W. Currier, W. Annapolis; St. U. of Iowa, Math.
R. H. Gilpin, Cumberland; U. of Illinois, Bot.
J. J. Hopfield, Bethesda; Swarthmore Coll., Phys.
E. Huff, Bethesda; Western Reserve U., Biochem.
J. E. Laynor, Bethesda; Carnegie Inst. of Tech., Eng.
H. I. Mandelberg, Baltimore; Johns Hopkins U., Phys.
L. S. Rodberg, Baltimore; Johns Hopkins U., Phys.
L. E. Scriven, II, Elkton; U. of Delaware, Eng.
T. D. Thomas, Chevy Chase; Haverford Coll., Chem.
C. V. Truss, Baltimore; Johns Hopkins U., Psych.

Massachusetts

M. S. Bryan, Cambridge; Copenhagen U., Bot.
E. C. Clarke, Concord; Radcliffe Coll., Biochem.
L. A. Currie, Somerville; U. of Chicago, Chem.
L. S. Harris, Brookline; Harvard U., Med. Sci.
R. J. Herrnstein, Newton; Harvard U., Psych.
W. T. Jenkins, Cambridge; M.I.T., Biochem.
H. M. Kaplan, Northampton; M.I.T., Math.
F. T. Kenney, Springfield; Johns Hopkins U., Biochem.
T. B. Knapp, Newton; M.I.T., Math.
J. K. Kopp, Dorchester; Harvard U., Phys.
A. M. Lacy, Newton Center; Wellesley Coll., Gen.
E. H. Lieb, Boston; M.I.T., Phys.
R. M. Lurie; Cambridge; M.I.T., Eng.
G. E. Mahoney, Norwood; Boston U., Math.
R. B. Marr, W. Bridgewater; Harvard U., Phys.
E. J. Ofengand, Taunton; M.I.T., Biochem.
R. S. Palais, Brookline; Harvard U., Math.
J. W. Pratt, Concord; Stanford U., Math.
S. A. Rice, Cambridge; Harvard U., Chem.
P. W. Robbins, Leominster; U. of Illinois, Biochem.
R. H. Romer, Cambridge; Princeton U., Phys.
F. W. Stahl, Needham; U. of Rochester, Gen.
R. D. Stolow, Brookline; U. of Illinois, Chem.
R. W. Thrasher, Greenfield; Williams Coll., Phys.
B. Tugendhat, Webster; Radcliffe Coll., Psych.
P. H. von Hippel, Weston; M.I.T., Biophys.
E. S. Weaver, Andover; Yale U., Chem.
C. A. Whitney, Cambridge; Harvard U., Phys.

Michigan

A. L. Albee, Mt. Clemens; Harvard U., Earth Sci.
J. W. Albrecht, Detroit; U. of Detroit, Phys.
S. A. Brady, South Haven; Western Michigan Coll., Chem.
G. W. Camiener, Detroit; Wayne U., Microbiol.
M. R. Dawson, Ferndale; U. of Kansas, Earth Sci.
H. M. Dess, Ann Arbor; U. of Michigan, Chem.
J. M. Gary, Kalamazoo; U. of Michigan, Math.
D. M. Green, Ann Arbor, U. of Michigan, Psych.
R. A. Hefner, Ann Arbor; U. of Michigan, Psych.
W. S. Jewell, Detroit; Cornell U., Eng.
L. E. Kaechele, Allegen; Stanford U., Eng.
D. F. Morrow, Detroit; Wayne U., Chem.
M. E. Munk, Detroit; Wayne U., Chem.
E. H. Poindexter, Lansing; U. of Michigan, Phys.
G. L. Schott, Huntingdon Woods; California Inst. of Tech., Chem.
O. J. Sexton, Pinckney; U. of Michigan, Zool.
A. E. Siegman, Pontiac; U. of California, Eng.
W. D. Slawson, Grand Rapids; Princeton U., Phys.
H. L. Smith, Ann Arbor; U. of Michigan, Eng.
G. A. Vidaver, Detroit; U. of Chicago, Biochem.
T. F. Waters, East Lansing; Michigan St. Coll., Zool.
A. M. Weitzenhoffer, Ann Arbor; U. of Michigan, Psych.

Minnesota

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T. E. Dickelman, Minneapolis; St. Olaf's Coll., Chem.
M. A. Eliason, Moorhead; Concordia Coll., Chem.
W. C. Erickson, Duluth; U. of Minnesota, Phys.
M. S. Fawcett, Winona; Northwestern U., Chem.
C. F. Giese, Minneapolis; U. of Minnesota, Phys.
R. E. Grant, St. Paul; U. of Texas, Earth Sci.
J. C. Holmes, South St. Paul; U. of Minnesota, Zool.
N. Horwitz, Minneapolis; U. of Minnesota, Phys.
F. J. Lyon, Minneapolis; U. of Minnesota, Eng.
R. L. Nickelson, Minneapolis; U. of Minnesota, Eng.
A. E. Ogard, Ada; U. of Chicago, Chem.
J. H. Osborn, Winona; U. of Minnesota, Chem.
J. F. Ready, Minneapolis; Coll. of St. Thomas, Phys.
P. C. Royce, Brainerd, Western Reserve U., Zool.
R. M. Straw, St. Paul; Claremont Graduate School, Bot.
J. D. Swalen, Minneapolis; Harvard U., Chem.
W. F. Wade, Minneapolis; U. of Minnesota, Eng.
N. M. Wolcott, St. Paul; Oxford U., Phys.

Mississippi

T. B. Breazeale, Brandon; U. of Virginia, Phys.
C. J. Brown, Utica; Mississippi Coll., Chem.
J. F. Garst, Jackson; Mississippi St. Coll., Chem.
E. E. Grace, Corinth; U. of North Carolina, Math.
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N. C. Merwine, Leakesville; Mississippi St. Coll., Agri.

Missouri

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J. H. Bell, Ferguson; Northwestern U., Eng.
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R. M. Cantwell, St. Louis; Washington U., Phys.
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L. S. Kisslinger, St. Louis; Indiana U., Phys.
L. H. Crone, Jr., Jennings; Washington U., Eng.
D. E. Leventhal, St. Louis; U. of Illinois, Biochem.
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J. W. Rittenhouse, Rolla; Purdue U., Eng.
B. P. Roe, St. Louis; Washington U., Phys.
G. H. Stout, St. Louis; Harvard U., Chem.
L. J. Tichacek, St. Louis; U. of Illinois, Eng.
K. G. Wernicke, Kansas City; U. of Kansas, Eng.

Montana

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J. E. Butcher, Albion; Utah St. Agri. Coll., Agri.
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J. A. Poirier, Harlowton; Notre Dame U., Phys.

Nebraska

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D. C. McGarvey, Omaha; Yale U., Math.
J. R. Munkres, Broadwater; U. of Michigan, Math.
R. L. Schelkopf; Shickley; U. of Nebraska, Agri.
W. F. Vogelsang, Lincoln; U. of Pittsburgh, Phys.
J. M. Yos, Lincoln; U. of Nebraska, Phys.

Nevada

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F. R. Jenson, Reno; Purdue U., Chem.
R. D. Smyth, Reno; U. of Chicago, Zool.

New Hampshire

D. D. Fitts, Keene; Harvard U., Chem.
W. F. Hoffmann, Manchester; Bowdoin Coll., Phys.
F. A. Johnson, Concord; U. of New Hampshire, Chem.

New Jersey

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R. C. Breslow, Rahway; Harvard U., Chem.
S. U. Chase, Princeton; Princeton U., Math.
G. A. Condouris, Passaic; Cornell U., Med. Sci.
R. J. Dietz, New Brunswick; M.I.T., Chem.
P. B. Eveleth, Neptune City; U. of Grenoble, Anthrop.
P. E. Gray, Livington; M.I.T., Eng.
O. W. Greenberg, Newark; Princeton U., Phys.
P. H. Greene, East Orange; U. of Chicago, Gen. Biol.
N. R. Harris, Port Norris; U. of Pennsylvania, Med. Sci.
R. Hobart, Jr., Ramsey; M.I.T., Phys.
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V. C. Pare, Woodbury; Cornell U., Phys.
W. Rusch, Lambertville; Princeton U., Eng.
J. A. Shropshire, New Gretna; Rutgers U., Chem.
M. S. Steinberg, Highland Park; U. of Minnesota, Zool.
R. G. Swan, Boonton; Princeton U., Math.
P. J. Warter, Jr., Trenton; Princeton U., Eng.
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W. G. Zoellner, East Orange; New York U., Chem.

New Mexico

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W. R. Kane, Los Alamos; U. of Washington, Phys.
G. W. Lecompte, Los Alamos; U. of New Mexico, Eng.
J. C. Phillips, Albuquerque; U. of Chicago, Phys.

New York

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L. E. Baum, Brooklyn; Harvard U., Math.
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P. J. Cohen, Brooklyn; U. of Chicago, Math.
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M. A. Cynkin, Brooklyn; Cornell U., Microbiol.
D. F. de Santo, New Rochelle; New York U., Eng.
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G. Feinberg, New York; Columbia U., Phys.
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W. Gilbert, New York; Harvard U., Phys.
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D. Horowicz, New York; Johns Hopkins U., Zool.
S. Kraüse, New York; Rensselaer Poly. Inst., Chem.
A. F. Kuckes, Yonkers; Gottingen U., Phys.
A. D. Laderman, New York; Columbia U., Zool.
H. J. Landau, New York; U. of Paris, Math.
D. B. Lewin, New York; Harvard U., Math.
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E. Lubkin, Brooklyn; Columbia U., Phys.
D. W. Lynch, Ithaca; Rensselaer Poly. Inst., Phys.
D. E. McCumber, Rochester; Yale U., Eng.
E. Mendelson, Brooklyn; Cornell U., Math.
J. J. Metzner, Long Island; New York U., Eng.
J. D. Musa, Farmingdale; Dartmouth Coll., Eng.
J. Nachmias, Brooklyn; Harvard U., Psych.
M. I. Nathan, New York; M.I.T., Phys.
N. P. Neureiter, Genesco; Northwestern U., Chem.
M. M. Nicely, Mount Kisco; U. of Berne, Zool.
D. S. Ornstein, Harrison; U. of Chicago, Math.
R. Pearlman, Long Beach; Harvard U., Math.
T. S. Piper, Elmira; Harvard U., Chem.
E. C. Posner, Brooklyn; U. of Chicago, Math.
D. Pratt, Ithaca; Cornell U., Agri.
L. Rosler, Brooklyn; Yale U., Phys.
D. Rothman, Bronx; U. of Wisconsin, Math.
J. L. Sackman, Rome; Cooper Union, Eng.
P. E. Sarachik, Flushing; Columbia U., Eng.
R. M. Scribner, Snyder; U. of Minnesota, Chem.
H. Seiwatz, Ithaca; Cornell U., Biophys.
R. F. Seiwats, Ithaca; Cornell U., Biophys.
C. M. Sommerfield, Brooklyn; Harvard U., Phys.
D. Spielberg, Richmond Hill; New York U., Phys.
E. M. Stein, New York; U. of Chicago, Math.
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W. J. Stein, Flushing; Manhattan Coll., Eng.
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S. H. Sternberg, Bronx; Swarthmore Coll., Math.

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North Carolina

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R. W. Heath, Chapel Hill; U. of North Carolina, Math.
K. Rondthaler, Ocracoke Island; Duke U., Bot.
W. V. Wright, Wilson; Harvard U., Math.

North Dakota

J. Adler, Grand Forks; U. of Wisconsin, Biochem.
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D. J. Parker, Fargo; North Dakota Agri. Coll., Chem.
P. E. Thomas, Fargo; Princeton U., Math.

Ohio

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H. O. Heisey, Louisville; Wheaton Coll., Biochem.
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D. R. Krieg, Lorain; U. of Rochester, Gen.
L. C. Lawrence, Cincinnati; Cornell U., Psych.
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D. Ryeburn, Goshen; Kenyon Coll., Math.
D. A. Slough, Findlay; Bowling Green St. U., Earth Sci.
D. A. Strang, Girard; Ohio St. U., Eng.
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P. N. Wolfe, Columbus; Ohio St. U., Phys.

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R. H. Bradford, Lawton; U. of Oklahoma, Biochem.
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C. R. Crane, Barnsdall; Florida St. U., Biochem.
J. H. Esslinger, Oklahoma City; Rice Inst., Med. Sci.
J. P. D. Hull, Tulsa; Columbia U., Earth Sci.
H. J. Kidd, Red Rock; Washington U., Gen.
E. B. Kilpatrick, Durant; U. of Oklahoma, Zool.
O. Kircher, Fairland; U. of Wisconsin, Eng.
C. F. Knutson, Ponca City; Stanford U., Earth Sci.
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M. A. Melton, Norman; Columbia U., Earth Sci.
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J. V. Parcher, Stillwater; Oklahoma A & M, Eng.
C. W. Reich, Oklahoma City; Rice Inst., Phys.
R. L. Willham, Stillwater; Oklahoma A & M, Agri.

Oregon

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J. W. Daly, Portland; Oregon St. Coll., Biochem.
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D. O. Geymer, Clackamas; U. of Washington, Chem.
M. P. Gray, Eugene; U. of Oregon, Anthrop.
B. L. Manley, Medford; Willamette U., Zool.
I. K. Mills, Corvallis; Oregon St. Coll., Bot.
E. Norbeck, Milwaukee; U. of Chicago, Phys.
D. L. Van Fleet, Portland; Lewis and Clark Coll., Biochem.

Pennsylvania

W. L. Baily, Jr., Waynesburg, Princeton U., Math.
P. B. Barton, Jr., Pittsburgh, Columbia U., Earth Sci.
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K. J. Cohen, Pittsburgh; Cornell U., Math.
V. H. Cohn, Jr., Reading; Harvard U., Med. Sci.
R. B. Curtis, Ardmore; U. of Illinois, Phys.
R. T. Denton, State College; Pennsylvania St. U., Eng.
R. H. Depue, Rutledge; U. of Illinois, Biochem.
R. E. Dessy, Blawnox; U. of Pittsburgh, Chem.
T. M. Devlin, Philadelphia; Johns Hopkins U., Biochem.
J. Engelberg, Philadelphia; U. of Pennsylvania, Biophys.
B. S. Fisher, Philadelphia; M.I.T., Chem.
R. T. Folk, Allentown; Lehigh U., Phys.
H. N. Garber, Philadelphia; M.I.T., Eng.
A. M. Goodman, Philadelphia; Princeton U., Eng.
M. P. Gouterman, Philadelphia; U. of Chicago, Biophys.
P. B. Green, Bala Cynwyd; Princeton U., Bot.
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P. M. Hurst, Jr., Hellam; Pennsylvania St. U., Psych.
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R. K. Miller, Harrisburg; U. of Delaware, Chem.
J. O. Montague, Pittsburgh; Carnegie Inst. of Tech., Phys.
J. T. Mullhaupt, Warren; U. of Rochester, Chem.
F. C. Neidhardt, Bucks Co.; Harvard U., Microbiol.
R. C. Newman, State College; Pennsylvania St. U., Eng.
C. J. Noel, Philadelphia; Villanova U., Chem.
R. E. Norton, Philadelphia; U. of Pennsylvania, Phys.
A. S. Obermayer, Philadelphia; M.I.T., Chem.
J. M. Olson, Philadelphia; U. of Pennsylvania, Biophys.
A. Plantz, Pittsburgh; U. of Illinois, Chem.
J. R. Powell, Bradford Woods; M.I.T., Eng.
H. A. Reiff, Allentown; U. of Minnesota, Chem.
K. Reibel, Philadelphia, Temple U., Phys.
J. A. Richman, Philadelphia; U. of Illinois, Math.
J. A. Romberger, Hershey; Pennsylvania St. U., Bot.
R. R. Sauers, Irwin; U. of Illinois, Chem.
R. F. Sawyer, Bethlehem; Harvard U., Phys.
L. R. Schissler, Alburtis; M.I.T., Eng.
A. E. Schraeder, Nanticoke, Carnegie Inst. of Tech., Phys.
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P. H. Squires, Ambridge; U. of Wisconsin., Eng.
W. Teutsch, Philadelphia; U. of Pennsylvania, Phys.
K. F. Wissbrun, Philadelphia; Yale U., Chem.
J. W. Woll, Jr., Newtown; Princeton U., Math.

Rhode Island

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L. Ekstrom, Providence; M.I.T., Chem.
R. Hermann, Kingston; Princeton U., Math.
J. N. Palmieri, Providence; Brown U., Phys.

South Carolina

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South Dakota

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R. R. Rankin, Draper; South Dakota Sch. of Mines, Earth Sci.

Tennessee

J. R. Cox, Jr., Nashville; Vanderbilt U., Chem.
L. Durand, III, Koxville; Yale U., Phys.
W. P. Flatt, Newbern; Cornell U., Agri.
F. R. Redwine, Chattanooga; U. of Tennessee, Eng.
J. C. Stewart, Sewanee; California Tech., Phys.
A. Stockell, Nashville; U. of Utah, Biochem.
S. G. Taylor, Jr., Memphis; U. of Alabama., Earth Sci.

Texas

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D. L. Amsbury, Houston; U. of Texas, Earth Sci.
C. L. Barker, Dallas; California Inst. of Tech., Eng.

R. L. Belford, Laporte; U. of California, Chem.
J. E. Cooper, III, Waxahachie; North Texas St. Coll., Chem.
J. W. Cronin, Dallas; U. of Chicago, Phys.
R. F. Curl, Jr., San Antonio; Rice Inst., Chem.
P. L. Donoho, Houston; California Inst. of Tech., Phys.
M. Dworkin, Austin; U. of Texas, Microbiol.
J. F. Gibbons, Texarkana; Stanford U., Eng.
W. C. Herndon, El Paso; Texas Western Coll., Chem.
L. S. Lockingen, Austin; U. of Texas, Biophys.
E. M. Magee, San Augustine; U. of Wisconsin, Chem.
J. B. Marion, Houston; Rice Inst., Phys.
J. S. Mecham, Austin; U. of Texas, Zool.
P. E. Peterson, Denison; California Inst. of Tech., Chem.
I. P. Trotter, Jr., Bryan; Texas A & M, Eng.
G. R. White, Abilene; U. of Wisconsin, Phys.

Utah

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R. Davis, Provo; Brigham Young U., Microbiol.
D. W. Esplin, Salt Lake City; U. of Utah, Med. Sci.
D. M. Grant, Salt Lake City; U. of Utah, Chem.
R. L. Snow, Salt Lake City; U. of Utah, Chem.

Vermont

N. A. Frigerio, Lyndonville; Yale U., Biochem.
R. C. Woodworth, Bennington; Pennsylvania St. U., Chem.

Virginia

J. H. Boyden, Wytheville; Carnegie Inst. of Tech., Phys.
K. C. Brannock, Independence; Emory U., Chem.
C. E. Coffey, Bristol; U. of North Carolina, Chem.
H. Everett, III, Alexandria; Princeton U., Phys.
M. M. Levine, Charlottesville; U. of Virginia, Phys.
W. W. Rennie, Richmond; U. of Wisconsin, Agri.

Washington

L. L. Anderson, Spokane; U. of Rochester, Biophys.
C. Ballantine, Seattle; Stanford U., Math.
D. M. Fahey, Walla Walla; St. Coll. of Washington., Chem.
M. P. Freeman, Seattle; U. of Washington, Chem.
P. A. Johnson, Seattle; U. of Washington., Eng.
D. B. Masson, Pullman; St. Coll. of Washington., Chem.
D. D. Nyberg, Camas; Oregon St. Coll., Chem.
R. A. Olsen, Pullman; St. Coll. of Washington, Microbiol.
D. L. Peterson, Seattle; U. of Washington., Chem.
C. J. Smiley, Mt. Vernon; U. of California, Earth Sci.
L. E. Wilson, Mount Vernon; U. of Washington, Chem.

Wisconsin

M. Alexander, Madison; U. of Wisconsin, Microbiol.
W. F. Battig, Wauwatosa; U. of Wisconsin, Psych.
R. J. Blattner, Milwaukee; Cambridge U., Math.
F. C. Brown, Madison; U. of Wisconsin, Psych.
S. D. Darling, Appleton; U. of Wisconsin, Chem.
S. C. Frautschi, Madison; Harvard U., Phys.
B. J. Hamilton, Manitowoc; U. of Wisconsin, Bot.
R. N. Hazelwood, Milwaukee; Marquette U., Biophys.
R. J. Holl, Madison; U. of Wisconsin, Phys.
J. W. Humbert, Kohler; U. of Wisconsin, Eng.
W. E. Magee, Madison; U. of Wisconsin, Biochem.
R. J. Plano, Merrill; U. of Chicago, Phys.
J. E. Quinlan, Milwaukee; U. of Arkansas, Chem.
J. W. Riese, Kaukauna; M.I.T., Phys.
D. F. Root, Madison; U. of Wisconsin, Eng.
J. H. Schneider, Madison; U. of Wisconsin, Med. Sci.
E. F. Silversmith, Madison; U. of Wisconsin, Chem.
R. A. Sneen, Menomonie; U. of Illinois, Chem.
E. C. Thiel, Wausau; U. of Wisconsin., Earth Sci.
J. D. Walecka, Wauwatosa; Harvard U., Chem.

Hawaii

A. S. L. Hu, Honolulu; U. of California, Zool.

Meetings and Elections

At the spring meeting of the **AAAS Cooperative Committee on the Teaching of Science and Mathematics** held in Chicago, Apr. 3–4, John R. Mayor of the University of Wisconsin was elected chairman. Dr. Mayor, for several years the representative of the Mathematics Association of America on the committee, succeeds Morris Meister, representative of the National Science Teachers Association. Laurence L. Quill of Michigan State College, representing the Division of Chemical Education of the American Chemical Society, was elected vice-chairman. Bernard B. Watson of the Operations Research Office of Johns Hopkins University, representing the American Association of Physics Teachers, was reelected secretary. Harold K. Schilling of Pennsylvania State University has recently been appointed to represent the AAAS Board of Directors on the committee.

Over 1500 engineering educators will attend the annual meeting of the **American Society for Engineering Education,** June 14–18, at the University of Illinois. The theme this year, "Evaluation of engineering education," will feature a thorough analysis of all phases of engineering education. This will conclude the Society's 2-yr study of the subject.

The meeting will include conferences sponsored by two component organizations of the ASEE, the Engineering College Administrative Council and the Engineering College Research Council. These groups will also hold a joint dinner to commemorate the 50th anniversary of the founding of engineering experiment stations in engineering colleges, a movement that has contributed very substantially to research progress in this country.

Educators and engineers from other countries who are visiting in the United States are cordially invited to attend. Foreign guests should write to Prof. Robert K. Newton, ASEE Housing Chairman, University of Illinois, Urbana, Ill., for information and reservations.

The whole of the 1954 **British Institution of Radio Engineers Convention**—which is being held at the University of Oxford, July 8–12—will be devoted to the application of electronics to industrial controls, processes, and computation. Over 30 papers are being presented, but there will be adequate time and facilities for discussion and demonstration. The program is divided into six sessions which include "Industrial applications of electronic computors," "Electronic methods of testing" (x-rays, ultrasonics, radioactive devices, etc.), and "Electronic control" (transducers, actuators, motor control, magnetic amplifiers, welding, etc.).

The final session, on "How electronics can increase production," will be opened by Sir Walter Puckey, president of the Institution of Production Engineers. For information write to the General Secretary, 9 Bedford Sq., London, W.C.1.

The **Summer Meeting of the American Association of Physics Teachers** will be held at the University of Minnesota, June 28–30, concurrently with meetings of the American Physical Society. In addition to a program of invited and contributed papers, round table

discussions on "Performance-type laboratory tests" and "The preparation of college teachers of physics" are being planned. A group breakfast is also scheduled for the morning of the total eclipse of the sun, which will be viewed from the University Airport.

The **Tennessee Academy of Science** has elected the following officers: pres., Myron S. McCay, University of Chattanooga; v. pres., Fred Wolfe, Vanderbilt University; treas., James W. White, University of Tennessee; sec., Isabel H. Tipton, University of Tennessee. The representative to the AAAS Council is Clinton Baker, Southwestern at Memphis.

Plans have now been completed for outstanding authorities on rocket development, astronautics and allied subjects to participate in the **Third Symposium on Space Travel** to be held at the American Museum-Hayden Planetarium on May 4. Joseph M. Chamberlain, chief astronomer and general manager of the Planetarium will open the program and introduce Arthur C. Clarke, author and rocket authority, who will serve as symposium coordinator. Mr. Clarke will also discuss "Astronautics—the historical perspective." Walter R. Dornberger, missile consultant of Bell Aircraft Corporation, will consider the subject, "Rocketry in Western Europe after World War I." The topic, "Russian rocket developments and their potential application to space flight," will be examined by George Sutton, supervisor of the Aerophysics Department of the North American Aviation Corporation, while R. C. Truax of the Guided Missiles Division of the Navy Bureau of Aeronautics will discuss "A national space flight program."

Harry Wexler, chief of the Scientific Services Division of the U.S. Department of Commerce, Weather Bureau, will discuss, "Observing the weather from a satellite vehicle." Fred S. Singer, professor of physics at the University of Maryland will speak on "The 'MOUSE'—minimum orbital unmanned satellite (earth), for astrophysical research" and Claude E. Shannon of the Technical Staff of Bell Telephone Laboratories will consider "Establishing communication with extraterrestrials." Among the guests expected to attend will be prominent representatives of the fields of astronomy, aviation, engineering, electronics, and medicine.

Necrology

Harold K. Barrows, 80, authority on hydraulic engineering, author, and professor emeritus at Massachusetts Institute of Technology, Cambridge, Mass., Mar. 15; **John E. Blackburn,** 80, retired topographic engineer for the U.S. Geological Survey, Washington, D.C., Mar. 6; **Marston T. Bogert,** 85, authority on synthetic organic chemistry, and professor emeritus at Columbia University, New York City, Mar. 21; **Henry E. Breed,** 76, civil engineer, author, lecturer, and former associate professor of highway engineering at New York University, New York City, Apr. 6; **Richard A. Burian,** 83, internationally prominent physiologist, Iowa City, Apr. 6; **Henry T. Chickering,** 68, pneumonia specialist and former chief of the tuberculosis clinic at Presbyterian Hospital, New York City, Mar. 14; **Cornelius J. Connolly,** 71, author and former head of the Department of Anthropology at Catholic University, Washington, D.C., Apr. 5; **Arnold Dresden,** 72, author, professor emeritus of mathematics, and chairman of the Department of Mathematics and Astronomy at Swarthmore College, Swarthmore, Pa., Apr. 10; **John F. Erdmann,** 90, professor emeritus of surgery at University Hospital, New York City, Mar. 27; **C. P. Fenwick,** 63, director of medical services for the Canadian Army in World War II, Montreal, Canada, Mar. 20; **Ludwig Jekels,** 87, psychiatrist and author, New York City, Apr. 3; **Sir Nelson Johnson,** 61, director of the Meteorological Office, London, England, Mar. 23; **Michael S. Kovalenko,** 65, retired assistant professor of mathematics and astronomy at Swarthmore College, Swarthmore, Pa., Apr. 2.

Clarence G. Lane, 71, author, professor emeritus, and former head of the Department of Dermatology at the Harvard University Medical School, Boston, Mass., Mar. 12; **Ralph M. Lecomte,** 68, retired professor of urology at Georgetown University Medical School and director of the Washington Medical Center, Washington, D.C., Mar. 11; **Jacques M. Le Mee,** 72, surgeon, author, and otorhinolaryngologist, Paris, France, Mar. 26; **Richard W. Linton,** 55, research chemist, author, and special assistant to the director of the International Department at Lederle Laboratories, Pearl River, N.Y., Mar. 29; **Fritz London,** 54, chemical physicist, author, and professor of physics at Duke University, Durham, N.C., Mar. 30; **Auguste Lumière,** 92, physician, physicist, chemist, botanist, inventor, and author, Lyon, France, Apr. 10; **Urban Maes,** 75, former professor and head of the Department of Surgery at Louisiana State University School of Medicine, New Orleans, La., Mar. 15; **Howard J. Milks,** 74, professor emeritus of therapeutics and small animal diseases in the New York State College of Veterinary Medicine at Cornell University, Ithaca, N.Y., Mar. 30; **Albert W. Morris,** 74, research metallurgist and inventor, Springfield, Mass., Apr. 1; **Oliver S. Ormsby,** 80, author and professor emeritus of dermatology at the University of Illinois College of Medicine, Chicago, Ill., Apr. 9; **Edsel A. Ruddiman,** 89, former professor of pharmacy and materia medica at Vanderbilt University, author, and research chemist for the Ford Motor Co., Detroit, Mich., Mar. 21; **Horace Seely Brown,** 77, professor emeritus of mathematics at Hamilton College, Clinton, N.Y., Mar. 27; **Willard Thompson,** 55, endocrinologist and clinical professor of medicine at the University of Illinois College of Medicine, Chicago, Ill., Mar. 23; **S. Burt Wolbach,** 73, eminent pathologist, retired Shattuck Professor of Pathological Anatomy at the Harvard Medical School, and director of the division of nutritional research at the Children's Medical Center, Boston, Mass., Mar. 19.

Book Reviews

The Nature and Significance of the Antibody Response. A. M. Pappenheimer, Jr., Ed. Columbia Univ. Press, New York, 1953. 227 pp. Illus. $5.

A collection of 14 papers presented to a symposium held at the New York Academy of Medicine in March 1951. The contents are as follows:

Theories of Antibody Formation by Felix Haurowitz; Sites of Antibody Formation by Phillip D. McMaster; Response of Immunized Animals to Specific and Nonspecific Stimuli by Jules Freund; Factors Influencing the Antibody Response by Geoffrey Edsall; Persistence of Antibodies in Man after Immunization by Michael Heidelberger; Unity and Diversity of Antibodies by Elvin Kabat; Valence of Antibodies by A. M. Pappenheimer, Jr.; Experimental Production of Skin-Sensitizing Antibodies by William Sherman; Skin-Sensitizing Antibody and Allergy and Resistance to Insulin by Francis C. Lowell; Immunological Reactions Mediated through Cells by Merrill W. Chase; Fate of I^{131}-Labeled Bovine Gamma Globulin in Rabbits by F. J. Dixon, S. C. Bukantz, G. J. Dammin, and D. W. Talmadge; Fate and Effects of Injected Protein Antigens by Charles A. Janeway; The Localization of Antigen in Tissue Cells by Means of Flourescein-Labeled Antibody by Albert H. Coons; and Radioactive Tracers in the Study of Antitissue Antibody by David Pressman.

The purpose of the symposium, as set forth in the preface, was to organize the present knowledge of antigen-antibody reactions in tissues. Unfortunately, this ambitious program was only partly realized. Because of the limited amount of detail and scope of material considered, the title of the book, as well as titles of the respective chapters, is more impressive than the contents. To those closely associated with this field, much of the material has a very familiar ring. The chapters on Sites of Antibody Formation and Unity and Diversity of Antibodies cover their subjects especially well, are clearly presented, and present reviews that heretofore have been treated only superficially.

In general, the discussions are concise and clearly present the work and thinking of the respective authors. The reader is likely to be disappointed in the very limited discussion of the participants which is included at the end of each of the three groups of papers. Pertinent questions dealing with the topics under discussion were not raised and, in some instances, questions that were raised were apparently ignored. This may have been due in part to the familiarity of the participants with one another and their work. There is so much current interest in the effect of radiation on antibody reactions and formation and the role of isohemagglutinins in blood disorders that these could have been considered more seriously. Regardless of one's familiarity with the significance of antigen-antibody reactions, however, the discussions are stimulating and present provocative concepts of fundamental importance.

DAN H. CAMPBELL

Gates and Crellin Laboratories of Chemistry
California Institute of Technology

Sexual Behavior in the Human Female. The Staff of the Institute for Sex Research, Indiana University: Alfred C. Kinsey, Wardell B. Pomeroy, Clyde E. Martin, Paul H. Gebhard, and others. Saunders, Philadelphia–London, 1953. 842 pp. Illus. $8.

The importance of this work in its field is second only to that of the preceding volume by Kinsey and his collaborators, the famous *Sexual Behavior in the Human Male,* which appeared in 1948. In the present instance, however, it is not necessary to give readers a digest of the volume. That has been adequately provided in the popular press. Nor is it necessary to describe in detail the methods of sampling, interviewing, and checking used in the analysis of the sexual histories obtained. What was said previously [*Quart. Rev. Biol.* 23, 39 (1948)] about the validity of the companion study applies sufficiently well to this one. In short, no such extensive report of human female sexual behavior has ever before been assembled; and controversial though certain methods and conclusions may be, no other study has been based on so many individuals (5940) or has attempted to provide an equal degree of statistical reliability. This will remain the primary source of scientific information on the subject for a long time to come. This being so, the present review may be devoted to constructive criticism rather than to summary or praise.

A striking feature of the current volume, in contrast to its predecessor, is the allotment of less space to the actual methodology and analysis and inclusion, instead, of a section of five chapters of more general discussion comparing the male and female in regard to the Anatomy of Sexual Response and Orgasm, the physiology of Sexual Response and Orgasm, Psychologic Factors in Sexual Response, Neural Mechanisms of Sexual Response, and Hormonal Factors in Sexual Response. This basic material is in part compiled from the scientific literature, and in part represents important, original observations on the nature of erotic physical response and the role of the total nervous system—central, peripheral, and automatic—in sexual stimulation and orgasm. Many of these findings are indeed essential to the authors' interpretations of the data analyzed in the earlier part of the book. Yet, from the mode of presentation, it is difficult to distinguish the original material from the secondhand. In fact, these approximately 200 pages might easily be supposed to have been added merely to make the book more useful, instructive, and interesting to 100,000 prospective nonscientific readers, although, in that case, surely they resemble too greatly the average college textbook to achieve their aim. There is, consequently, a grave suspicion that the authors have fallen between two stools. With one eye on the clamoring public, they have curtailed the analysis of their data to an unfortunate degree and deviated from the simplest and most logical plan of organization. With the other eye directed toward their fellow-scientists, they have included tables, graphs, and text that make the book, in literary style and character, a volume for the serious student and by no means for the casual fancier of the subject.

The foregoing criticism of the treatment of the data needs to be explained more fully. The sample obtained

in the study of sexual behavior in the male was a "stratified sample," that is, one in which the attempt was made to secure an adequate sample from each of the categories and subcategories into which the population appeared to be divided on the basis of race, marital status, age of adolescence, current age, educational level, occupational class of the subject, occupational class of parents, religious group, degree of religious adherence, and rural or urban background. From such a sample, if the proportions of the groups in the total population are known, the behavior of the total population can be reconstructed by properly weighting the several categories. But the total sample as such tells nothing about any universe except itself. It must be analyzed in terms of its separate groups.

Now in the study of sexual behavior in the female, on account of practical difficulties, the effort to obtain an adequate stratified sample was abandoned. The authors (p. 36) regard the sample as inadequate at many points, especially for age groups over 50, for educational levels 0–8 (grade school) and 9–12 (high school), for previously married females, for all Catholic groups and for devout Jewish persons, for laboring groups, rural groups, and individuals born before 1900. Geographically, the U.S. Southeast, Pacific Northwest, and Plains and Mountain States are poorly represented. Quite properly, therefore, the authors have refrained from any attempt to reconstruct the sexual behavior of the entire U.S. white female population. Nevertheless, throughout the book, the analysis devotes much attention to the *total* sample, without exclusion of individuals who represent the inadequately sampled groups. This total sample consequently represents nothing except itself. It possibly reflects quite accurately the behavior of females in particular groups, for example, Protestant college women aged 20 to 60. The analysis, however, is not made primarily in the form of a series of comparisons between adequately sampled groups. It is in fact difficult, if not impossible, from the form of the presentation to determine what proportions of the total sample come from the adequately sampled groups; and the misplaced emphasis upon the total sample in chapter after chapter is likely to mislead readers seriously and to encourage overgeneralization. At the very least, in presenting the data, the total sample might have been separated into two parts: information derived from adequately sampled groups, and that derived from all other groups. In a study that is otherwise so valuable, this is a serious defect.

A second major criticism may be directed at the intermingling of objective reporting of data, on the one hand, and subjective opinions of the authors, on the other. No one ought to object to the statement of opinions on the subject of sexual behavior—its normal forms, its legal aspects, its diversity and relation to religious origins and prohibitions—by those who have acquired so extensive a knowledge of present sexual practice in America. Yet scientists might expect that conclusions drawn directly from reported behavior—for example, regarding the frequency in certain groups of certain types of behavior—would be clearly separated from opinions regarding what is right or wrong, what is desirable or undesirable, what is historically traceable to one influence or another. Kinsey's study of sex behavior started out to be a biologist's analysis of actual practice, based on personal reports. In spite of precautions, it often seems to culminate in propaganda for certain sociological views: that what is common in sexual behavior must be right; that the Judaeo-Christian culture imposes undesirable restraints upon normal and natural sex activities; that inhibition of sexual outlet, in some form or other, is biologically as well as psychologically unhealthy and unwise; or that certain laws ought to be changed. To some extent, this is the consequence of the fairly widespread, earlier criticism by psychiatrists and sociologists that Kinsey's group had not paid sufficient attention to the diverse aspects of sexual behavior and the social values involved. As a result, the staff was considerably expanded, to include, among others, two research associates in legal studies and consulting editors in psychiatry, psychology and neurophysiology, sociology as well as statistics. Yet no matter how fully we may agree with these points of view, scientists are surely justified in expecting that the objective findings of the study will be kept distinct from a consideration of ethical and sociological implications. True, the subjective opinions are in the main gathered into sections clearly labeled: "Significance of . . . Moral Interpretations; Legal Implications; Social Significance . . ." and so forth. But these sections might far better have been separated altogether from those chapters in which the actual data are analyzed and discussed. A part of the failure of this book to achieve the widest possible acceptance by all serious students of sexual problems may then be fairly attributed to this indistinctness between scientific and social conclusions. Yet in all fairness, this is in large part not so much a matter of what the authors have said or how they have said it, but rather of the organization of the book as a whole.

To conclude, the authors would on several grounds have achieved their divided purposes better had they written two distinct books: one, an even more exhaustive and critical analysis of the reported data; and second, a truly popular treatment of the subject embodying a summary such as that which appeared in *Life Magazine*, a general discussion of comparative sexual behavior in the male and female, and a consideration of the ethical and sociological implications of the study.

BENTLEY GLASS

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Glycols. American Chemical Society Monograph 114. George O. Curme, Jr., Ed., and Franklin Johnston, Assoc. Ed. Reinhold, New York, 1952. 389 pp. $12.

This monograph deals with the production, physical properties, applications, condensation polymers, physiological aspects, analysis, and testing of the various glycols that are now in commercial production or have been or could be so produced. The authors of the various chapters, which are clearly and concisely written, are members of the Carbide and Carbon Chemicals Company staff.

The content leans rather heavily toward the technical aspect and, perhaps, one of the more important contributions of the book is the excellent coverage and presentation of data that are buried in the patent literature. Thereby, one of the principal purposes of the monograph, "to make available to chemists a thorough treatment of a selected area," has been fully achieved. However, this publication lacks somewhat in fulfilling its second purpose, "to stimulate further

research in the specific field treated." A more critical discussion of the chemical reactions from the viewpoint of modern theories of organic chemistry would have been desirable; moreover, the authors could have pointed out more of the unsolved problems in the field.

HENRY FEUER
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The Determination of Adrenocortical Steroids and Their Metabolites. Proceedings of a conference held by the Society for Endocrinology, London, May 21, 1953. P. Eckstein and S. Zuckerman, Eds. Dennis Dobson, London, 1953. 91 pp. Illus. 12s 6d.

In his closing remarks as chairman, Professor G. F. Marrian states that ". . . many of us have come to realize that most of the methods which have been in general use [for the determination of the steroids] are unsatisfactory and [we] are doing something to devise better ones and . . . are prepared to discuss are difficulties frankly among ourselves." The current effort on both sides of the Atlantic to develop new methods and to standardize existing methods is manifest in the fact that two conferences on the subject were held almost simultaneously in May 1954 at the Medical Society of London and at the Worcester Foundation in Shrewsbury, Mass. The memoirs of the Society for Endocrinology, No. 2, will be particularly welcome to workers in this field, not only for spotlighting the valuable recent British contributions to the general problem of steroid analysis, but also for the candor of the discussions in which the reader will recognize with familiarity many of the bothersome trivia of technique which seem to show no geographic discrimination in whom they plague.

The volume consists of 10 brief papers and relevant discussions on various aspects of corticosteriod determination in blood and urine. Problems associated with the estimation of "formaldehydogenic substances" and the stability of such substances in urine are discussed in two brief papers from Marrian's group. Among the novel and promising tools referred to in several of the papers are the sensitive arsenomolybdate color reaction of V. Schwarz; the ingenious bismuthate procedure of J. K. Norymberski for oxidizing the C_{20}-17-hydroxycorticosteroids to 17-ketosteroids as conjugates, directly in urine or in urine extracts; and the extraction of urinary conjugates by ethanol-ether mixtures by A. E. Kellie and coworkers. The evaluation of the combination of the last two techniques as a routine analytic procedure suggests a new tool with many future applications. Several papers deal with the evaluation of dehydroepiandrosterone in urine, and the nature of the corticosteroid fraction of normal and pathological urine (before and after ACTH), but only one paper deals with the problem of estimating the corticosteroids of peripheral blood.

Not the least noteworthy is the paper by S. A. Simpson and J. F. Tait on the isolation of a "weighable" amount (less than 1 mg) of electrocortin, the highly active sodium-retaining factor of adrenal tissue, its purification, and details of the evidence accumulated for the α-ketol and α,β-unsaturated ketone functions of the substance.

This excellently printed small book constitutes a good digest of many new advances in the field of the corticosteroids and their analysis. The procedures and technical details outlined by the various authors will serve to stimulate those already engaged in steroid analysis. As a guide to some recent and valuable literature, this book is highly recommended.

KENNETH SAVARD
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The Physics of the Stratosphere. R. M. Goody. Cambridge Univ. Press, New York, 1954. 187 pp. Illus. $5.

According to Goody, *The Physics of the Stratosphere* was written for the physicist interested in learning something of a field other than his own. Writing in an easy and lucid style, he has been successful in presenting the principal problems before the stratosphericist and in pointing out the difficulties that beset their solution. Unlike the laboratory experimenter, the upper air physicist is unable to perform controlled experiments in which different parameters are varied at will. He is forced, therefore, into the role simply of observer and must attempt to interpret his observations without knowing for sure what parameters actually underlie the observed phenomena. This is repeatedly illustrated in Goody's book, as a wide variety of methods for determining the temperatures, composition, motions, and radiations in the stratosphere are reviewed. The principal criticism I have is that the most recent results from rocket experiments are not always included. Nevertheless, the book will be of interest, not only to the reader for whom it was written, but also to the geophysicist himself, as a handy, clear, objective and accurate summary of important techniques and results in stratospheric research.

The book opens with an introductory chapter, in which a brief historical review of the discovery of the stratosphere is given. It is pointed out that upper air nomenclature may be based on a variety of atmospheric features, such as temperature structure, dynamical factors, chemical composition of the air, and ionization. A uniform nomenclature has not been settled upon, and some terms have different meanings to different users. To some, the stratosphere lies between the tropopause and 20- or 30-km altitude. Goody uses the term to denote the region between the tropopause and the bottom of the ionosphere at about 80 km. It is with this region that the book is mainly concerned. The introductory chapter concludes with a brief review of upper air research vehicles: balloons, aircraft, and rockets.

The second chapter takes up the problem of determining startospheric temperatures. Balloon observations of the lower stratosphere are summarized, and the relationships between the troposphere, the tropopause, and the lower stratosphere are discussed. The author quite properly emphasizes that in balloon temperature observations there are always the difficult problems of insuring that the thermal element comes into conductive equilibrium with the air rather than into radiative equilibrium with its surroundings, and of shielding the thermal element from solar radiation during daytime flights. Next Goody

reviews sound propagation studies, in which sound waves emanating from explosions on the earth's surface and refracted back to the earth from the stratosphere are used to determine winds and temperatures in the region from about 30 to 60 km. He summarizes the results so obtained. He fails, however, to note that this technique has also been employed in a more direct fashion by ejecting grenades from flying rockets and exploding them in the stratosphere itself. The study of visual and photographic meteors as an approach to upper stratospheric temperatures is discussed, and results are given. Goody points to the pioneering work of Lindemann and Dobson in this connection, and quite properly chooses to present in detail the more recent and more precise theory of F. L. Whipple and coworkers. Then there appears a review of rocket experiments. Unfortunately, the rocket results presented are long out of date; much better data have been available in the literature for some time. The chapter on temperature is concluded with a survey of numerous observations that tend to confirm the temperature picture obtained from sound, meteor, and rocket studies. The confirmatory evidence is found in observations of noctilucent clouds, theory of atmospheric oscillations, measurement of scale heights and electron collision frequencies by ionospheric sounding techniques, study of the auroral and night airglow spectra, and scattering of light from vertically directed high-power searchlight beams.

Chapter III deals with the composition of the stratosphere. Along with the major constituents, water vapor, carbon dioxide, the rare gases, nitrous oxide, and methane are discussed. Balloon, spectroscopic, and rocket techniques are described, and results are listed. In connection with the rocket measurements, Goody describes the taking of samples that appear to show diffusive separation in the stratosphere between 60 and 70 km. Specifically, it was found that the ratios of both helium and neon to nitrogen in the samples increased, while the ratio of argon content to nitrogen decreased with altitude. Because the increase in the light gases and the decreases in the heavier argon are in keeping with what one would expect if diffusive separation did occur, Goody comments that there is little doubt that the observations are reliable. More recently, however, many have come to believe that the observed separation could and did occur in the somewhat lengthy intake tube into the sample bottles, raising considerable doubt about the early interpretations of the data.

To the important subject of stratospheric ozone, the author devotes his longest chapter, providing an excellent and much needed summary of the subject. In Chapter IV, he points out the importance of ozone in the heat and radiation balance of the atmosphere and describes various ground-based, balloon-borne, and rocket methods for its study. The principal means for the determination of atmospheric ozone content is found in the absorption of solar radiation by the gas, and Goody gives a number of approaches that use this means, together with results. He describes methods for the determination of the temperature of the zone layer based on a study of the ozone itself. He presents numerous results, including summaries of world-wide observations on the total ozone content as a function of season. The apparent connection between total ozone and weather is pointed out, particularly the high correlation between ozone amount and potential temperature in the stratosphere. Finally, Goody presents a photochemical theory of the formation of the ozone layer, basing his discussion on the calculations of Craig. These calculations, however, rested on the assumed existence of photochemical equilibrium, which is probably not a valid assumption below 40 km. At the same time, he ignored the effect of the reaction

$$O + O + M \rightarrow O_2 + M,$$

which the theoretical results of Bates and Nicolet, and also of F. S. Johnson and coworkers, have shown to be not negligible above 50 km. It would have been better, I feel, to have quoted Johnson's calculations, which include the effect of recombination of oxygen atoms.

Chapter V gives a brief treatment of winds and turbulence in the stratosphere. For the lower stratosphere, the variation of wind speeds and directions with season and with altitude are discussed. The existence of a "jet stream" near the tropopause is pointed out. In the upper stratosphere, the observation of visual meteor trains and radio meteor trails is described. There is a brief reference to rocket smoke puff studies.

In Chapter VI, Goody closes with the fascinating, difficult, and important subject of radiation. He discusses the solar constant and presents a rocket determination of the solar energy spectrum in the near ultraviolet. He goes on to discuss various wavelength bands in which atmospheric absorption may be expected. The integral equations needed to solve the problem of the radiation balance in the atmosphere are set up, and the formidable obstacles in the way of any numerical solution are listed. Some theoretical results obtained by introducing simplifying assumptions are given, as for example Gowan's calculations on the temperature structure of the ozonosphere. I feel that Johnson's calculations on the diurnal variation of temperature in the ozone layer might well have been included, inasmuch as they are based on rocket measurement of the solar radiation actually absorbed at the various levels treated. Johnson's results show considerably smaller diurnal variation than do Gowan's figures.

In summary, *The Physics of the Stratosphere* is an easily readable, illuminating discussion of upper air physics. The subject matter is well organized and ably handled, giving the reader a clear insight into some of the major problems and difficulties of stratospheric research; and, except in the case of rocket upper air studies, the book provides the reader with a good picture of the current status of the field. Many of the criticisms I have made are plainly matters of judgment, and in this the author must of course have the final say. In physical appearance, the book is quite pleasing, and the publishers are to be congratulated on having done an artistic job. Finally, there are some minor errors that are pointed out simply for the convenience of the reader and the publishers. (Some proper names have been misspelled: p. 31, Atanasoff; p. 49, Rateliffe; p. 65, Camp Ripley; p. 118, Deming.) I recommend the book both to workers in upper air physics and to those others who have, or think they might be induced to have, an interest in the upper atmosphere.

HOMER E. NEWELL, JR.

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Technical Papers

Biochemical Limnology[1]

J. R. Vallentyne

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A major part of limnological research has centered about the relationship between the chemical composition of lake waters and sediments on the one hand, and the physiology of phytoplankton and rooted plants on the other hand. A limited amount of success has been achieved in this direction, largely from the study of inorganic ions such as phosphate, nitrate, and ammonia. Few serious attempts have been made to include organic compounds in such studies (*1–6*). Yet it is well known (*1*) that the dispersed organic matter (dissolved plus colloidal) of lake water generaly exceeds the particulate (seston) by a factor of 5–10. The dispersed organic matter constitutes an important part of the chemical environment, one whose biological significance is uncertain because the analyses have been for elements rather than for molecules. This is no less true for the organic matter of sediments.

This article gives a general account of results obtained during the 4 years of my study. More detailed treatments will be published elsewhere.

Acid hydrolysates of the dispersed organic matter from Lower Linsley Pond, Conn., and Lake Opinicon, Ont., were qualitatively examined for amino acids. Amino acids were separated on paper using butanol-acetic acid and phenol as solvents. In both lakes, the following amino acids predominated: aspartic, glutamic, alanine, leucine and/or isoleucine, and a fifth that occupied a position not quite identical to that of methionine. The same amino acids predominated in seston from both lakes and also in sediment from Lower Linsley Pond, suggesting a qualitative similarity in the amino acid composition of seston, water, and sediment. The relative abundance of acidic and neutral amino acids is dissimilar to the data for Wisconsin lakes (*2*).

A second phase of biochemical limnology has been developed in conjunction with R. G. S. Bidwell, of Queen's University: a study of the free sugar contents of Connecticut lake sediments. Free sugars were found in all sediments studied (Lower Linsley Pond, Lake Waramaug, Lake Quassapaug, Lake Quonnipaug, and East Twin Lake). The total amount of free sugar varied from 24 to 72 mg/kg dry weight of ethanol insoluble sediment (92 to 300 mg/kg ignitible matter). With the exception of one sample, glucose comprised more than half of the total free sugar. Other free sugars found in lesser quantity were galactose, arabinose, xylose, and ribose. The amounts of free sugars found in Connecticut lake sediments were surprisingly high, approaching the figures given by Bidwell, Krotkov, and Reed (*7*) for fresh algae, Chlorophyta excluded. This suggests that free sugars are not so quickly decomposed in sediments as has hitherto been assumed for all simple organic nutrients in lakes. This suggestion is strengthened by results of sugar analyses on sediments from Bethany Bog, Conn., known to be 5000 to 9000 yr old (age was estimated by comparing pollen zonations from Bethany Bog with those from Upper Linsley Pond which have been dated by C^{14}). Free glucose was found in these samples, the concentrations varying from 1 to 11 mg/kg dry weight of ethanol insoluble sediment (3 to 24 mg/kg ignitible matter). It can be shown by indirect means that some diagenetic destruction of glucose occurred in these relatively old sediments.

Another biochemical approach to limnology stemmed from a study of the carotenoids and chlorophylls of sediments. Carotenoids were first found in lake sediments by Trask (*8*) and later by Baudisch and von Euler (*3*). The carotenoids of sediments appear to resemble those of fresh plant tissues (*9*), but the chlorophylls differ (*10, 11*). The acetone-soluble green pigments of sediments are called chlorophylls here; however, it should be realized that there is no basic evidence to indicate that this is the correct terminology.

Although carotenoids are highly labile in the laboratory, Fox, Updegraff, and Novelli (*10*) found that they resisted complete destruction in marine sediments estimated to be 8000 yr old. These workers realized that it might be possible to use carotenoids as biochemical fossils in marine sediments. I have extended this approach to fresh-water sediments. Using paper chromatography (*12*), a semiquantitative method has been developed for the separation and estimation of the carotenoids and chlorophylls of sediments. The chief importance of the method is that it provides a new measure of plant abundance in lake sediments, one that does not require the preservation of biological form.

The most interesting result of this work concerns the epiphasic carotenoid, myxoxanthin, which has been tentatively identified in acetone extracts of lake sediments. The only fresh-water organisms known to contain this compound are the blue-green algae. Examination of the sediments of Bethany Bog revealed the presence of myxoxanthin throughout the eutrophic phase of development, but when the sediments recorded a change to a dystrophic (acid, bog water) lake, myxoxanthin was no longer found. This suggests a decrease in populations of blue-green algae coupled with the onset of dystrophy. This conclusion, suggestive at best, could not have been derived from "morphological" paleontology. Microscopic examination of the samples failed to reveal the presence of blue-green algae. In another lake, Upper Linsley Pond, myxo-

[1] This work has been supported by the National Science Foundation, the National Research Council of Canada, and the McLaughlin Science Fund of Queen's University. Grateful acknowledgment is made to Professor G. E. Hutchinson for guidance during the study.

xanthin was found both in the bottom and near-surface samples. This lake is not yet truly dystrophic.

Carotenoids and chlorophylls have been found in Connecticut lake sediments that are up to 11,000 yr old. Concentrations of all carotenoids and chlorophylls do not progressively decline with depth. In the Bethany Bog core, a carotenoid tentatively identified as rhodoviolascin reached maximal values in the uppermost sediments, carotene (alpha plus beta) in the middle section of the core, whereas a third carotenoid (not yet identified) had maximal values in the lowermost part of the core.

Such results indicate the promise of the approach, even though the interpretation may be difficult. It is unlikely that much reliable information will come from the study of plant pigments in lake sediments until a great deal more is known about their destruction in lake waters and sediments.

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Occurrence of Structurally Preserved Plants in Pre-Cambrian Rocks of the Canadian Shield

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A small but varied assemblage of primitive lower plants, representing both blue-green algae and simple forms of fungi was discovered recently by the writers in nonferruginous cherts of the Gunflint iron formation of southern Ontario. The plant fossils were first observed in dense black cherts collected from the lower "algal" members of the Gunflint formation near Schrieber, Ontario, but additional material has been secured from widely separated localities along the strike of the formation. The collective plant remains thus far studied constitute a small, but significant, flora of remarkably ancient plant life.

As far as we are aware, these plants are the oldest structurally preserved organisms that clearly exhibit cellular differentiation and original carbon complexes which have yet been discovered in pre-Cambrian sediments and, as such, are of great interest in the evolutionary scheme of primitive life. Their discovery likewise appears to validate the somewhat questionable organisms described by Gruner (*1–3*) from the pre-Cambrian of northern Minnesota and tend to support the evidence presented by Rankama (*4*) regarding the organic origin of *Corycium enigmaticum*, a supposed organism of pre-Cambrian age.

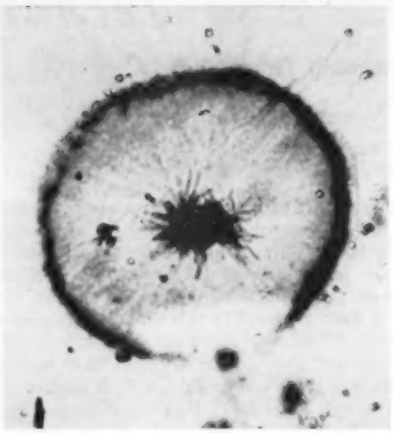

FIG. 1. Globose colony showing actinomorphic central mass of filaments surrounded by the remains of what is interpreted as a gelatinous "sheath." "Sheath" is outlined by mineral stain, partially ground away in lower quadrant of colony. Thin section, × 725.

Although detailed studies of the plants and comparisons with existing forms among lower groups of algae, fungi, and protophyta are being carried out, it seems desirable at this time to present a preliminary

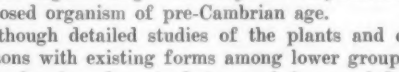

FIG. 2. Aggregation of colonies similar to that shown in Fig. 1. Black threads at upper and lower left are unbranched free filaments, not associated with the globose colonies. Thin section, × 325.

statement regarding these organisms and outline their possible biological affinities and geologic significance.

The organic residues of the plants occur in a matrix of fine- to medium-grained chert containing occasional carbonate rhombs. The petrographic character of the plant remains varies from amber brown to coalified and opaque. The majority of the organic constituents, attrital material as well as structurally distinct plant parts, however, is relatively uncoalified and remarkably uncompressed. The quality of preservation of the plants and the lithologic appearance of the chert in thin section is quite comparable to that of the celebrated Rhynie chert deposit of the middle Devonian of Scotland. Fragments of the original plant parts, in particular the spores and longer filaments, may be released from the embedding chert by dissolving the silica in hydrofluoric acid. Such released portions may be washed free of acid, pipetted onto microscope slides and examined directly, free of the mineral matrix.

Thus far, five morphologically distinct organic entities have been recognized, of which two are algal, two fungal, and one a unicellular type, probably a calcareous flagellate. The algal forms are of two diverse types: one consists of free, unbranched filaments, devoid of heterocysts and spores, with filaments approximately 1.5 μ in diameter; the second consists of colonial, actinomorphic aggregates of short filaments embedded in what appears to be the silicified remains of a globular mass of "jelly" (Figs. 1 and 2). The first of these may be compared to certain species of the existing genera Lyngbya or Oscillatoria, although the comparison is limited to only the grossest of morphological detail. The globular colonial forms may be compared to such existing groups as the Rivulariaceae, although the more extensive development of the globular sheath, complete absence of heterocysts, and extremely thin filaments in the fossil forms are significant features that differentiate them from Rivularia and its related genera. It should be noted, however, that certain genera of the Rivulariaceae are devoid of heterocysts.

Of the two fungal types observed, one form has been found to consist of many-branched hyphae, apparently nonseptate, bearing small sessile laterally attached spores (Fig. 3), a structural feature comparable to that found in certain existing Phycomycetes. The second fungal form consists of matted hyphae, abundantly branched and nonseptate (Fig. 4). Numerous spores occur distributed throughout the mycelial mass, but none have been observed to be clearly attached. In addition to the mycelia found in distinct aggregates, numerous isolated spores, possessing well-defined reticulate sculpture, and probably of fungal origin, have been noted in several thin sections of the chert.

Unicellular organisms, or the dissemination or calcareous platelets of multicellular colonial forms (flagellates?) occur in considerable profusion in the chert. Of these, one distinctive form has been recognized, a cell of radially symmetrical organization,

FIG. 3. Portion of a mycelium with attached sessile spore. The black areas are coalified portions of the same mycelium. Hypha and spore attached are light amber brown in transmitted light. Thin section, ×1025.

resembling that found in the genus Discoaster, a group of planktonic calcareous marine flagellates of uncertain systematic position, probably related to the Coccolithophorides (*5*). It is hoped that further study will establish the presence of other unicellular forms and some evidence concerning their systematic position in terms of existing groups, despite the limitations of structural detail provided by the fossils.

The general stratigraphic position of the Gunflint iron formation, containing the organisms noted here, is generally regarded as middle Huronian (*6*) on the basis of correlation with the Negaunee iron formation of the Marquette district in Michigan. Several age

FIG. 4. Portion of a mycelium showing branching, nonseptate hyphae and detached spores. Thin section, ×725.

determinations, by helium measurements, of magnetite from the upper portion of the Negaunee iron formation range from 800 million to 1650 million years and average 1300 million years (*7*). Since the pre-Cambrian flora with which we are dealing comes from near the base of the Gunflint formation, it seems likely that age may approach 2 billion years.

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Hemoglobin Regeneration Following Oral Administration of Chelated Iron

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Published evidence suggests that heavy metals attached to a chelate nucleus are available to plants but not to animal organisms. Stewart and Leonard (*1*) reported iron in the form of ferric potassium ethylenediamine tetraacetate to be readily utilized by chlorotic grapefruit trees when applied to the soil. On the other hand, Brendel *et al.* (*2*) administered several heavy metal-chelate combinations intraperitoneally to mice and obtained indirect evidence which led them to postulate that heavy metal ions attached to the chelate nucleus are not available to the animal body. We became interested in determining, by a direct experiment, whether or not this is true.

It is well known that extreme nutritional anemia can be induced in young rats maintained on a milk diet. The hematinic effect of iron added to the diet of the anemic rats is then clearly reflected in the rate of hemoglobin regeneration. Mitchell and Miller (*3*) showed that, in this procedure, the optimum daily iron requirement for a rat is about 0.25 mg if sufficient copper supplement is provided.

Fifty male, recently weaned, Sprague-Dawley rats were placed on a diet of powdered whole milk and water *ad libitum*. Blood hemoglobin determinations by the direct photometric method (*4*) were made on tail blood at intervals. At the end of 7 wk, the blood hemoglobin levels were uniformly low in more than two-thirds of the animals, and 30 of the most uniformly low animals were selected and divided into three groups of ten animals each.

Iron supplementation in the diet was then instituted in two of the groups. The first group received 0.1 mg iron per rat daily in the form of ferrous sulfate. The second group received the same daily dose of iron in the form of ferric sodium ethylenediamine tetraacetate (*5*). The third group received no iron and served as a control. These are suboptimal levels of iron intake, so intended in order to show possible differences in ab-

TABLE 1. Blood hemoglobin levels of anemic rats treated orally with ferrous sulfate and chelated iron.

Group	No. of animals	Form of iron	Average blood hemoglobin levels (g/100 ml) (5–26–53)	(6–9–53)	(6–23–53)	(7–8–53)	(7–22–53)	(8–3–53)
I	10	Ferrous sulfate	5.4 (± 0.4)*	8.2 (± 1.3)	10.5 (± 1.3)	11.6 (± 1.1)	11.4 (± 1.7)	12.3 (± 2.0)
II	10	Ferric sodium ethylenediamine	5.4 (± 0.5)	7.5 (± 1.3)	10.4 (± 0.5)	11.2 (± 0.8)	11.3 (± 1.1)	11.9 (± 1.8)
III	10	Control (no iron)	5.5 (± 0.4)	4.6 (± 0.5)	3.6 (± 0.4)	3.5 (± 0.3)	†	—

* Standard deviations.
† Controls in poor condition, two dead; see text for fate of remaining eight animals.

TABLE 2. Blood hemoglobin levels of anemic rats treated intravenously with saccharated iron oxide and chelated iron.

No. of animals	Form of iron	Average blood hemoglobin levels (g/100 ml) (7–15–53)	(7–22–53)	(7–29–53)	(8–3–53)	(8–12–53)
4	Saccharated iron oxide	3.5 (± 0.4)*	5.1 (± 0.4)	8.3 (± 0.2)	11.6 (± 1.4)	12.0 (± 1.5)
4	Ferric sodium ethylenediamine tetraacetate	3.5 (± 0.1)	4.2 (± 0.6)	4.6 (± 1.0)	5.4 (± 0.7)	5.2 (± 0.6)

* Standard deviations.

sorption or utilization of the two forms of iron. All three groups received 0.025 mg copper per rat daily as copper sulfate. Supplementation was carried on for a total of 9 wk. Blood hemoglobin determinations were made on tail blood at six different intervals during the supplementation period.

The average blood hemoglobin levels in Table 1 clearly indicate that the iron from the iron chelate was absorbed from the gastrointestinal tract and utilized for hemoglobin regeneration in the anemic rat at the same rate as iron from ferrous sulfate. Using the average figure of 6.7 ml of blood per 100 g body weight for the white rat, supplied by Cartland and Koch (*6*), and the generally accepted figure of 0.335 percent iron for the iron content of hemoglobin (*7*), an approximate calculation indicated that the rats were approaching 100-percent utilization of administered iron from both forms of iron during the early weeks of the experiment. The percentage utilized tapered off as the blood hemoglobins began to approach normal levels.

Fecal examinations were made several times during the course of the experiment. Feces from the ferrous sulfate group were usually slightly darker in color than those of the control group. Feces from the iron chelate group were usually softer and lighter in color than those of the controls. At autopsy, the lining of the stomach and gastrointestinal tract of the animals in both groups showed blackened areas. In the case of the iron chelate animals, this indicates that at least some of the complex was being broken down in the gastrointestinal tract, since the unbroken complex will not release iron to form sulfides of iron. Animals maintained on a milk diet with only the copper supplementation do not develop blackened areas in the gastrointestinal tract.

The effect of iron chelate administered parenterally was also explored in a preliminary way. When the control group had continued 6 wk beyond their depletion period on the iron-free diet, they had very low blood hemoglobin values, two had died, and the remaining eight were in poor condition. These eight were divided into two groups of four each, and intravenous therapy was instituted at a dosage level of 4 mg iron per kilogram twice weekly. One group received a solution of saccharated iron oxide (*8*). The other group received a sterile solution of 1.0 percent ferric sodium ethylenediamine tetraacetate (Table 2). Both groups continued to receive copper supplementation in the milk diet.

The poor hemoglobin response of the rats that received chelated iron intravenously is in accord with the postulate of Brendel *et al.* Once introduced into the body parenterally as the heavy metal complex, the metal ions remain attached to the complexing nucleus and are not readily available to the body. The parenteral results in turn lend further support to our suspicion that, following oral administration, iron is released from the chelate by some mechanism in the gastrointestinal tract before being absorbed. This mechanism is presently under further study.

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Studies of Copper Chlorophyllin-Odorant Systems[1]

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The use of chlorophyllins (water-soluble derivatives of chlorophyll) has been reported (*1*) for the effective reduction of breath odor, but no explanation of a mechanism by which such odor reduction is possible has been forthcoming in terms of the principles of physical chemistry.

By independent measurements, we have found that buffered (*2*) "solutions" of potassium copper chlorophyllin (*3*) will take up appreciable quantities of odorant, which can be estimated by titrating the solution with odorant to an olfactory end-point. In addition, we have measured the physical adsorption of gases onto powdered chlorophyllin (Table 1). In view of the marked difference between the two experimental techniques, the results are in surprisingly good agreement.

This observed adsorption is both physical and chemical, and where both occur, they may be of approximately equal magnitude. The physical adsorption is of the Langmuir type. Surface area by the BET method for several preparations of chlorophyllin is of the order of 15 m^2/g.

The fact that chlorophyllin does not form true water solutions but rather polyelectrolyte dispersions can be demonstrated by determinations of molecular-weight distribution and of intrinsic viscosity, and by precipitation with alcohol and with electrolytes. Chlorophyllin is about 75 percent nondialyzable through Cenco cellophane tubing; the particle weight is, therefore, primarily greater than 12,000. The particle weight of 3.6 percent of a sample is larger than 1-million as determined by sedimentation in a preparative centrifuge. The precipitation of chlorophyllin by ethanol increases linearly with the concentration of alcohol, and this suggests a continuous range of particle weights. Viscosity data (*4*) give straight-line functions for c/η_{sp} vs. $\sqrt{c}$ and fit a Fuoss Formulation giving $[\eta] = 0.33$; this indicates that particles are

[1] This paper was delivered at the meeting of Section C of the AAAS in Boston, Dec. 27, 1953.

TABLE 1. Adsorption of chlorophyllin.

Material	Temperature (°C)	Moles adsorbed per mole† chlorophyllin	Reversible
A. Amounts of odorants* taken up in "solutions" of potassium copper chlorophyllin as measured by an odor titration			
Amyl mercaptan		0.005	No
n-propyl mercaptan‡		.01	No
Diallyl sulfide		.01	No
Diisobutyl ketone‡		.03	
Vanillin		.08	
Trimethyl amine		.09	Yes
Limonene		.1	Yes
Ethyl acetate‡		.2	
n-valeric acid		.3	Yes
Thioglycolic acid		.3	No
Hexamethylene diamine		1	Yes
Hydrogen sulfide		5	No
B. Amounts of several chemicals adsorbed on solid chlorophyllin as measured by gas adsorption			
Ethyl acetate	35	0.2	Yes
Methyl ethyl ketone	35	0.1	Yes
Nitrogen	−196	$0.1_5 - 0.2$	Yes
Hydrogen sulfide	25	0.4_5	0.2_5 No, 0.2 Yes
Amyl mercaptan	35	0.3_5	0.3_5 No, 0.04 Yes

* The odorant taken up was corrected by the titration of a blank without chlorophyllin.
† A mole of chlorophyllin is taken as 690 g.
‡ No buffer was used.

probably spherical with diameters possibly as large as 0.02 micron. Ultracentrifuge and light-scattering molecular-weight determinations have failed because of the interfering intense green color of chlorophyllin.

The adsorption of odorants by other surface active materials in aqueous dispersion has been measured for comparison by the odor titration technique (Table 2). All adsorption is reversible on heating, except on chlorophyllin. For n-valeric acid, all data are comparable, except for hydrophilic silica gel. For amyl mercaptan, the greater affinity of chlorophyllin can be explained by the nonreversible chemisorption.

These adsorption data can be explained by the principles of adsorption processes. Physical adsorption is reversible and minimized at low temperature; chemisorption, because of the high energies of adsorption, is nonreversible and minimized at low temperatures, because of the high activation energy required for chemical reaction. Interpretation of the foregoing

TABLE 2. Adsorption at the odor end-point of valeric acid and amyl mercaptan by an aqueous dispersion of materials of high specific surface.

Adsorbent	Surface area (m^2/g)	n-valeric acid (10^{-5} mole/m^2)	Amyl mercaptan (10^{-6} mole/m^2)
Carbon black	180	3	4
Activated charcoal	10	2.7	3
Attapulgus clay	3	4	5
Diatomaceous earth	0.8	< 8	5
Silica gel	300	0.04	0.09
Chlorophyllin	15	2.8	50

data indicates that both types of adsorption by chlorophyllin are involved. For chemisorption, surface saturation is possible at all concentrations. For physical adsorption, monolayer formation may not take place at low concentrations, and the amount of adsorption may be very small. However, the data reported in Tables 1A and 2 depend on an olfactory end-point and indicate actual amounts of odor adsorbed at threshold concentrations of odorant.

Recent work (*5*) indicates that perceptible variations in odor perception can be expressed in chemical concentration as

$$C/C_{th} = 10^N,$$

where C is the detected concentration and C_{th}, the threshold concentration, and the perceived level N is limited to the following ranges: $N = 1$ (just detectable), $N = 2$ (weak), $N = 3$ (medium), $N = 4$ (strong), and $N = 5$ (very strong). Thus, a perceived odor reduction from medium to weak changes the concentration ratio from 1000 to 100 and 900 parts of the odor have been removed to reduce this perceptible difference.

This explains, for the first time, the reduction of odor by chlorophyllin in terms of the surface properties of adsorbent materials and the laws of odor perception. The help of Prof. Irwin W. Sizer, Biology Department, Massachusetts Institute of Technology, is gratefully acknowledged.

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Communications

On "Different IQ's for the Same Individual Associated with Different Intelligence Tests"

In his small, clinically oriented study, Dreger (*1*) illustrates the point that even when a given subject is tested several times by the same examiner, using the intelligence scales with which this examiner feels most confident, the individual's IQ scores probably vary considerably. He concluded that "whereas group means on different tests of intelligence *may* not differ except by chance from one another, individual's IQ's may differ widely *and significantly* from one another on different tests" (p. 595, italics mine). Both portions of this statement may be misleading. By private correspondence, Dr. Dreger has assured me that he did not ignore the considerable body of literature which shows rather conclusively that the mean IQ score for a group of individuals usually varies markedly from test to test (for example, see *2–8*). Rather, he apparently meant that, even though the test means do not differ significantly for a certain group of testees, there may still be idiosyncrasies that result in greater-than-chance discrepancies between the highest and lowest obtained IQ scores of some individuals. This is equivalent to saying that testees have different "true" scores on the two tests which in the long run sum over individuals to approximately the same figures.

If only two scores on the same two tests were available for each testee, this true-score comparison would be tantamount to saying that the individuals by tests interaction is significant. But with a randomized block design, the $i \times t$ mean square serves as the denominator of the two F tests, and there is no "error" term available for testing its significance. This same situation prevails no matter how many individuals and/or tests are used. A design involving retesting or comparable forms of the same test is needed to provide an error estimate for the $i \times t$ interaction. I plan to discuss this problem elsewhere.

Furthermore, Dreger's "assumption that the tests which yielded the highest and lowest IQ's for each subject could have been by chance the two tests administered if only two were administered in any clinic" (p. 594) is an untenable basis for setting up a two-way classification (individuals by highest-lowest IQ) and running a t test of the difference between the correlated means, because it capitalizes heavily upon chance fluctuations to accentuate improperly the apparent significance of the difference. This is not the same as comparing individual means in the analysis of variance, with adjusted probabilities, after the overall F test for treatment means has been found significant.

Because of marked uncontrolled sources of heterogeneity in Dreger's study, coupled with the small number of subjects upon which it is based, the application of any type of statistics appears undesirable. Instead, I recommend that the 39 scores be viewed only as an illustration, certainly not as proof, of variability under particular clinical conditions.

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A recent article by Dreger (*1*) ends with the sentence, "Therefore, it can be concluded that whereas group means on different tests of intelligence may not differ except by chance from one another, individual's IQ's may differ widely and significantly from one another on different tests."

Dreger's data do not establish this conclusion, because, as he seems to have suspected, he concocted an interesting way of misinterpreting results obtained from a perfectly respectable statistical method. Ten

Table 1. IQ's of 10 children, each tested four times on the Stanford-Binet (the form used is shown below the IQ).

Subject	Test 1		Test 2		Test 3		Test 4	
	CA	IQ	CA	IQ	CA	IQ	CA	IQ
1	37	111	50	106	64	106	76	118
		L		L		M		L
2	73	110	85	112	97	109	109	116
		L		L		M		L
3	30	123	42	129	54	113	60	117
		L		M		L		M
4	35	109	45	107	55	129	62	123
		L		L		M		L
5	37	97	51	106	53	104	57	100
		L		L		M		M
6	35	143	43	142	54	131	61	125
		L		M		L		M
7	31	126	44	127	55	125	62	115
		L		L		M		L
8	56	141	57	151	60	143	92	146
		L		M		L		M
9	30	110	36	106	48	121	50	122
		L		L		L		M
10	84	155	95	179	107	157	119	173
		L		L		M		L

children were given four (or, in one case, three) different tests, each of which yielded a score that could be converted into an IQ. Two columns were then set up, in one of which the child's highest IQ was entered; in the other, his lowest. Dreger then misused statistical methods to determine that the highest IQ's are higher than the lowest IQ's. Perhaps this is obvious to the reader; if not, our Tables 1 and 2 should clarify the matter.

The data in Table 1 were supplied to me by Stott (*2*) from records at the Merrill-Palmer School in Detroit. These cases were simply taken in order from among those who had been tested four times with the Stanford-Binet, the best known and the most reliable of the tests used by Dreger.

TABLE 2. Comparison of lowest and highest IQ's.

Lowest IQ	Highest IQ	Highest minus lowest
106	118	+12
109	116	+ 7
113	129	+16
107	129	+22
97	106	+ 9
125	143	+18
115	127	+12
141	151	+10
106	122	+16
155	179	+24

The highest and lowest IQ's and their differences are shown for each subject in Table 2. All differences are, of necessity, positive. Their mean is 14.6, their standard deviation is 5.3, the standard error of the mean is 1.8, and the t ratio of 8.1 is, as was Dreger's, significant beyond the 0.001 level. However, this does *not* prove that "IQ's may differ widely and significantly from one another on different tests." All that is proved is that in some or in all cases, a child may get at least two different IQ's if he is tested four times. This is true without regard to whether he is tested on four different tests or on the same test. It is also true of any kind of measurement. Thus, we would get exactly the same results if we simply weighed 10 children on four different days (using either the same or different scales).

Dreger's little study has, thus, contributed nothing to the problem he tackled, the constancy of the IQ. He has, however, well illustrated what every psychologist knows: A child's IQ will be similar, but not identical, on successive testings. This is true whether one or more tests are used.

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JULIAN C. STANLEY's comment on my article helps to correct some misimpressions a brief article often gives. There are several points, however, that may need clarification in Dr. Stanley's letter.

The conclusion of my article, to which reference is made, was not intended to take in all the many experiments showing significant differences among IQ tests for the same individuals. These latter are mainly on group tests, of course, in contrast to the more carefully administered individual tests of my experiment. My conclusion was not based only on a comparison of highest and lowest IQ's for the same subject, but mostly on an analysis of variance and the relative lack of correlation among the tests. When I said that for the entire group IQ's from different tests may not differ except by chance, I merely intended to make a cautious introduction to the major clause based on the evidence immediately at hand, to the effect that individual IQ's may differ, *even though* group means may not, as they did not in this case.

I agree with Dr. Stanley's analysis of treatments by subjects design, what he calls $i \times t$ design. His discussion is relevant; though, from a strictly statistical standpoint, a mixed design of some sort might be better. From such a standpoint, a design unconfounding examiner and examinee variables would be best, but this type of design would circumvent the problem of my experiment.

In part, Dr. Stanley's discussion loses sight of the problem which was: Do IQ's obtained from the same individuals *in a clinical setting* on different tests differ and significantly? A careful reading of my article will reveal that the entire situation is couched in terms of clinics. I can, of course, think of several designs that could eliminate examiner variance from the error term for testing subject effects. Confounding was recognized and mentioned both in the report to the Florida Psychological Association and in the article. But to quote from the article: "The design was intended to duplicate the actual clinical situation where one examiner gives several tests to the same person." If the design of an experiment eliminates the conditions generating the problem it is intended to answer, the experiment may answer some question but not the experimental one.

In connection with the "untenable basis for setting up a two-way classification," a quotation from my original report to the Florida Psychological Association seems in order:

> The comparison here seems the most indefensible statistically, for the extremes are compared, rather than any two IQ's taken at random. Yet both from logical and statistical standpoints a rationale (which is not necessarily a rationalization) can be supplied. Statistically one may say that the test meets the demands for a significance level. Adopting Fisher's criterion of one in $\frac{1}{2}n(n-1) \cdot 20$ as the level of significance, the obtained level, beyond .001, is considerably below the required .008. Logically, the fact that in clinical practice the choice of any two of these tests could be made and could yield these extremes of IQ's justifies to an extent assigning each individual a High and a Low score for comparison.

I did point out in the *Science* article that the procedure was questionable, but limits of space prevented elaboration. Dr. Stanley is correct in stating that my procedure is not the same as a t test following an F test.

Since I utilized statistics in planning and carrying out my study, I naturally disagree with Dr. Stanley's final paragraph. Various sources of heterogeneity were controlled experimentally, the training of examiners, the time lapse between testings, age distribution, representativeness of tests, and two other variables not mentioned in my article, socio-economic background to some extent, and "normality" of emotional behavior. From a methodological standpoint, I believe that all experiments are only illustrations. The only way I know further to show whether my experiment constitutes what might be called "proof" is to have it repeated, perhaps with a more efficient design, as long as the design in the interest of efficiency does not tackle a different problem from that set up here. *Whether or not* the means of groups differed, I should predict that the same general result would obtain, that individuals would differ by more than chance within themselves on different IQ tests.

Dr. Albert K. Kurtz' remarks are partially answered by the foregoing statements. His last paragraph and his Table 1 demonstrate that apparently I did not make the experimental problem clear: "Dreger's little study has, thus, contributed nothing to the problem he tackled: the constancy of the IQ." I was not concerned with that particular problem, which I did mention in passing in the first paragraph of my article. Instead, the question asked was: "What about the constancy of the same individual's IQ as reported on *different tests at approximately the same time?*" (Italics unfortunately are not in the original.)

Kurtz' Table 1 shows IQ's on the *same* test (assuming as we both do evidently that Binet L and M are equivalent) across periods ranging from 20 to 39 months. In the life of a child, the period from 3 to 6 years is a very long time, or even from 7 to 10 (Subject 10). As is apparent, Kurtz' problem and mine are different. An analysis of variance reveals, as in my case, that his Binet tests do not differ significantly from one another (as tested against interaction mean square). But aside from the fact that he is citing the same test used on different occasions, his procedure is not the same as mine. My experiment was set up so that a between-examiner variance would not inflate the differences among tests. I presume that Merrill-Palmer examiners would be different from time to time or randomized by happenstance among subjects and times. Kurtz' results are a tribute to the excellence of the Binet test but are not directly comparable to the results of an experiment employing a different procedure.

One comparison may be made between Kurtz' Table 1 and my Tables 1 and 2. A rank correlation of Kurtz' data, using Kendall's W, yields a coefficient of .81, which by a chi square test (*1*) is significant beyond the .001 point. Such a result might have occurred if only four tests had been used in my experiment, so that all ten subjects could have entered into the rank correlation. With six subjects, however, the correlation was not significant on three tests. With eight subjects on three tests, one different from the last, chi square is just below significance at the .05 point.

Rather than engage in this sometimes fruitless interchange on my experiment, I should rather repeat the experiment. Because of administrative changes, I am not at present in a position to do so, although I expect to be in such a position again. I hope somone will repeat it. If my results are not verified—on the same problem, not a different one—I shall be happy to acknowledge publicly that what I called a "limited answer to the question" is more limited than I am ready now to admit.

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Chemical and Physical Characteristics of Delaware River Water from Trenton, N. J., to Marcus Hook, Pa., 1949–52

The Delaware River is the principal source of water for many industries and municipal water supplies in the reach of the river from Trenton, N. J., to Marcus Hook, Pa., and both industry and municipalities use it for disposal of their wastes.

Interest in the quality of the water in the Lower Delaware was manifested in the latter part of 1930 when the natural flow of the Delaware River was unusually low and the salinity of the river increased markedly. Officials of industries that were affected initiated salinity investigations of the stream. A daily sampling program by the U.S. Geological Survey was started in 1944, at Morrisville, Pa.

On the basis of measurements during the period between Aug. 1949 and Dec. 1952, we observed that the mineral content of the water increases from Trenton to Marcus Hook. During protracted periods of low flow (which occurs only during the late summer months) salt water moves up the river along the river bottom and is partially mixed with the river water as a result of currents from tidal action and other factors. This saline invasion causes chloride content to increase sharply at Eddystone and at Marcus Hook, and near its mouth the river water tends to approach the composition of sea water. During these periods, higher concentrations of dissolved solids are observed at the bottom of the river than near the surface.

During normal flow, there is more calcium than magnesium and more sulfate than chloride in the water. This relationship is reversed when the downstream flow is low and ocean water mixes with the river water. At such times, we observed dissolved solids concentrations as much as 4150 ppm at Mar-

cus Hook but only about 250 ppm at Philadelphia-Camden Bridge.

From a sanitary viewpoint, the quality of the river water improved during this period; the number of samples with low dissolved oxygen has decreased. However, the water contains less dissolved oxygen as it flows downstream, indicating that oxygen is being consumed by oxidizable matter. From Philadelphia downstream, there are periods, particularly in the late summer, when dissolved oxygen is barely sufficient to meet the oxygen demands of the pollution load.

Maximum water temperatures are observed in July and August; the highest observed was 88°F. The minimum temperature observed, in January, was 32°F. There is practically no difference in temperature of the river from shore to shore and usually is within 1°F from top to bottom.

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The Chemical Quality of Surface Waters in Devils Lake Basin, North Dakota

For many years the decline in level of Devils Lake in northeastern North Dakota has been a matter of concern. Once a popular resort area in the state, the total area of lake surface had shrunk from about 90,000 acres in 1867 to about 6500 acres in 1940, and had become a shallow body of stagnant, brackish water, unsuited for game fish. A plan of the Department of Interior related to the utilization of Missouri Basin waters includes a proposal to restore Devils Lake to a higher level by indirect diversion of Missouri River water.

The investigations by the Geological Survey of the quality of water in Devils Lake basin from November 1948 to December 1952 included the following considerations: the present salt concentration and properties of lake waters; the extent to which salinity of the waters could be reduced by inflow of fresh water from outside the basin; the volume of inflow and outflow that would be required to maintain tolerable salt concentrations; and properties of the inflow waters.

Scattered records from 1899 to 1923 and more comprehensive data from 1948 to 1952 show a range of salt concentration from 6130 parts per million (ppm) to 25,000 ppm in Devils Lake water. Although the concentration has varied, the composition of dissolved solids has not changed appreciably. Lake waters are more concentrated in the lower part of the basin; for periods of record, the salt concentration ranged from 19,000 to 106,000 ppm in East Stump Lake. The computations show that the probable minimum and maximum concentrations to be eventually reached at lake level 1425 ft are 600 to 1050 ppm for Devils Lake and 690 to 1500 ppm for Stump Lakes. The amounts of dissolved solids in all lakes might total as much as 8 million tons before water is released in the Cheyenne River. It was also observed that because many waterways in this basin have no surface outlets at normal stages, runoff collects in depressions, is concentrated by evaporation, and forms saline or alkaline lakes.

During several years of average precipitation, temperature, and evaporation, Devils Lake and lakes upstream should receive nearly a quarter of an inch of runoff annually from the drainage area of about 300 mi^2. However, the amount of runoff in the basin and the amount retained in upstream lakes varies greatly from year to year; therefore, annual inflow to Devils Lake is extremely variable.

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Modification of the Glacial Chronology of the San Juan Mountains, Colorado

Atwood and Mather (*1*) recognized till of three different ages in the San Juan Mountains of Colorado: the Cerro, of pre-Wisconsin age, the Durango, now believed of early Wisconsin age, and the Wisconsin, now believed of late Wisconsin age. Remapping in the drainage of the East Fork of Dallas Creek, west of Ridgeway, suggests that Atwood and Mather's Durango and Wisconsin tills each represent two glacial advances, and that deposits of two still younger glaciations lie in the cirque heads.

In the area examined, the Cerro till is about 400 ft thick. Its position on an isolated divide, about 1000 ft above the creek, and its very strongly developed profile of weathering are the basis of its correlation by Mather and Atwood with the deposits of the Buffalo stage of Wyoming.

The Durango till comprises two sets of well-developed lateral and partly preserved terminal moraines, each with associated outwash deposits. The outer terminal lies at an altitude of about 7900 ft; the inner at about 8000 ft. Deposits associated with the inner moraine trench the outer moraine in such a way as to suggest that the moraines represent two advances of the ice separated by an interval of erosion. The moraines may, therefore, be considered as upper and lower units of the Durango till and are here correlated with deposits of the first and second advances of the Bull Lake stage of Wyoming (*2*), which I believe to be of Iowan and Tazewell ages.

The Durango till has a relatively strongly developed soil profile that is locally overlain by deposits associated with the next glacial advance. The profile is less well developed than that on the Cerro till but is more mature than soil profiles on younger tills. It is believed equivalent to the Brady soil of Nebraska.

Atwood and Mather's Wisconsin till also comprises two distinct terminal moraines, separated by an interval of erosion. The outer moraine lies at an altitude of 9100 ft, the inner at 9350 ft. They appear to represent separate advances of the ice and may be considered as upper and lower units of this till. I correlate them with deposits of the first and second advances of the Pinedale stage of Wyoming (*2*), which I believe to be of Cary and Mankato ages.

Both moraines of Atwood and Mather's Wisconsin till have a moderately developed soil profile that is locally overlain or truncated by younger deposits. It is believed to have formed during the "altithermal" interval.

Deposits of two even younger glacial advances, not recognized by Atwood and Mather, are found in all the cirques in the Dallas Creek drainage. The older is typified by a bouldery moraine on the lip of the cirque northeast of Mount Sneffels at an altitude of 11,300 ft. The moraine is trenched about 20 ft by the stream. The soil profile on the till is thin, azonal, and very weakly developed as compared with that on adjacent till of late Wisconsin age. It supports scrub spruce and grass. Overlapping this moraine is a younger, large and well-formed rock glacier, which I believe to be of glacial origin and to have formed during the latest glacial episode. This and other rock glaciers in the region were mapped by Atwood and Mather but were considered of landslide origin. The deposit appears stagnant and supports some lichen, though no soil profile is developed on fine-grained till exposed at its surface. It grades into active talus at the cirque headwall. The deposits of these two youngest glacial episodes are both of Recent age, and are both included in the "little ice age" of Matthes (*3*). Deposits of the older advance are correlated with those of Hack's Temple Lake stage of Wyoming (*4, 5*), which I consider of post-"altithermal" Recent age. Deposits of the younger advance formed during the latest glacial episode from about A.D. 1640 to 1860. Reconnaissance shows that this glacial succession is widespread throughout the San Juan Mountains.

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On the Growth of Root Hairs

In a recent article on the growth and osmotic conditions of root hairs, Ivar Ekdahl (*1*) rejects my views and formulates a new hypothesis concerning the growth of these structures. Because of the fundamental importance of the problem, it seems that a comment on Ekdahl's article is in order.

At the end of a long series of experiments I (*2, 3*) concluded that the root-hair wall consists of cellulose and calcium pectate continuous with corresponding layers in the hair-forming cell. The presence of calcium pectate in the maturing hair walls renders them harder and less subject to distortion. During growth, the wall of the root-hair tip remains active and more yielding than that of the sides, and hardening is brought about by the gradual formation of calcium pectates from the tip of the hair to the base. The progressive hardening of the pectic layer confines this softer spot to a narrow area at the growing tip where new wall material is being constantly laid down, and this determines the narrow diameter of the full-grown hair.

Ekdahl explains the hardening of the growing root-hair wall in another way. He stresses the importance of pectic substances at the root-hair tip but ignores them entirely in the hardening process. In his opinion, "the hardening of the wall from the very tip to the sides may . . . take place through a gradual formation of cellulose strands, which are first dispersed, but, as the wall is thickened and matured, will be oriented in the direction of the long axis of the hairs." In rejecting the calcification theory of root-hair growth, he offers the hypothesis that elongation is brought about by the continuous softening of the growing apical wall by action of pectic and cellulosic enzymes.

The evidence marshalled by Ekdall in support of his hypothesis does not withstand critical examination. His chief argument in opposition to the formation of calcium pectates in the maturing hair wall is that little change in the rate of root-hair elongation took place within a wide range of calcium-ion concentration in the external medium. This observation, based on the rate of root-hair growth, is no proof that calcification did not occur. The *rapidity* with which root hairs elongate depends entirely on other factors and has no place in the argument.

Ekdahl's other argument, that root hairs develop vigorously in moist air where no external calcium supply is available, lacks creditability also. There is no evidence that root hairs grow any differently in moist air than they do in an aqueous medium, or that there is any difference in their cell walls (*2, 3*). In moist air, the calcium for cell-wall formation comes from that originally stored in the seed. A little calcium under moist-air conditions could go a long way in affecting the necessary linkages for the production of calcium pectates. Experiments *in vitro* with pure pectic acid (*2*) showed that there are weakly and strongly calcified pectates; and the more recent work on the chemistry of pectic substances reviewed by Ekdahl (*1*) serves to strengthen this opinion.

In discussing my calcification theory, Ekdahl makes no attempt to explain the fact that anything that prevents gradual calcification (whether ammonium oxalate, excessive acidity, or excessive alkalinity) also prevents the development of root hairs, at the same time bringing about the exact results one can foretell, assuming this hypothesis to be correct (*2, 3*). Neither does he take into account the marked cessation of abnormalities and the sudden burst of long, straight hairs that occurs when roots grown in ammonium oxalate solutions are transferred to a calcium solution (*2*).

Recent experimental findings by Dale (*4*) on root hairs, Facey (*5*) on leaf abscission, Weintraub (*6*) on leaf movement, Northcraft (*7*) and Anderson (*8*) on the separation of free-living cells, and Burström (*9*) on calcium as a growth factor emphasize the importance of calcium as a cell-wall constituent. This fresh evidence and the frailty of Ekdahl's supporting argu-

ments do not warrant any immediate change in my theory of root-hair growth.

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Geology of the Iron Deposits of the Congonhas District, Minas Gerais, Brazil

Large iron deposits in the state of Minas Gerais, Brazil, have been the subject of a continuing study by geologists of the U.S. Geological Survey and its Brazilian counterpart, the Departmento Nacional da Produção Mineral under the sponsorship of the Institute of Inter-American Affairs. These deposits are very large and will unquestionably have great future importance, although they have not yet been extensively developed because of their remoteness from the world centers of heavy industry. Reports and maps on the Congonhas district (600 km^2) and other parts of the ferriferous region, which has a total area of several thousand square kilometers, will be published as the work in each district is completed.

The deposits are of three general types: (i) laminated iron formation, or itabirite, consisting of varying proportions of specular hematite (Fe_2O_3) and magnetite (Fe_3O_4), quartz (SiO_2), and lime-magnesia carbonate; (ii) masses of nearly pure specular hematite enclosed in the iron formation; and (iii) surficial cappings of limonite ($Fe_2O_3 \cdot nH_2O$).

Itabirite is a metamorphosed sedimentary rock that occurs principally as the middle member of the pre-Cambrian Minas series. Within the Congonhas district, it ranges in thickness from about 100 to 600 m or more. The average iron content is estimated to be 40 percent. Quartzite and mica schist underlie the itabirite conformably; phyllite with lenticular quartzite, dolomite, minor amounts of itabirite, and some volcanic rocks overlie it. It is believed that the unusual ferruginous sediments were deposited as chemical precipitates of iron oxide, colloidal silica, and alkaline earth carbonates brought into a restricted marine environment by one or more large rivers. The landmass was low; hence, little or no clastic material was introduced. Somewhat acid conditions inhibited the precipitation of carbonates over most of the period of deposition. An offshore volcanic arc probably cut off circulation between the basin and the open ocean, and volcanic emanations may have aided in lowering the *p*H below the "limestone fence."

Regional metamorphism accompanying severe folding produced specularite and quartz from the siliceous precipitates and magnetite, dolomite, and quartz from the carbonate-bearing sediments. Platy specularite was partially oriented to form an incipient cleavage.

Faulting, in the course of superimposing several large thrust slices, brecciated the iron formation and opened channelways for hydrothermal solutions of unknown source. These solutions replaced the quartz and dolomite with new specularite, giving rise to the local development of high-grade ore deposits. Preexisting bedding, cleavage, and breccia structures were faithfully preserved by fine-grained (average 0.01 mm), unoriented, interlocking hematite that contrasts sharply with the unreplaced platy specularite. Magnetite octahedra, some a centimeter across, were partly or completely altered to hematite. Both proximity to faults and variations in the carbonate content of the original formation localized replacement; the largest known deposit of the district occurs where dolomitic itabirite was overridden by a thrust block.

Descending ground water has leached most of the carbonate and part of the quartz from the itabirite above the water table. Hydration and reprecipitation of iron as limonite over most of the outcrop areas have formed hard cappings, which protect the underlying softened material from rapid erosion. Remnants of old surfaces several hundred meters above present-day intermontane valleys indicate intermittent uplift in recent geologic times.

Surficial leaching has dissolved minor quantities of iron from some hematite ores, destroying the intergranular cohesion and producing friable or powdery material. Mosaic-textured ore with interlocking, sutured grain boundaries resists this leaching better than ore with tabular, oriented specularite grains; and weathering, therefore, exhumes original sedimentary structures that were preserved during metamorphism and replacement.

As the Congonhas deposits have many features in common with numerous iron formations and hematite ores on all continents, their genetic environment, although unusual, was presumably not unique.

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Special-Purpose Terrain Evaluations

The U.S. Geological Survey in collaboration with the Soil Survey of the U.S. Department of Agriculture has been engaged for more than 10 years in making special terrain evaluations for application to military planning and operations. This work has been supported mainly by the Corps of Engineers, U.S. Army.

The major military problems considered in the work deal with two main types of use of terrain. The first is construction on and below the ground surface of a wide variety of structures, some peculiar to military activity, but most having counterparts in civilian life. The basic terrain problems in construction have been formalized as a result of extensive and prolonged world-wide research in engineering geology and soil engineering for military and civilian purposes.

The second broad use of terrain is in rapid move-

ment of men and equipment across the surface of the ground away from established roads. Unlike military construction, cross-country movement has few immediate counterparts in civilian life and, therefore, has been studied almost exclusively in terms of the military application. The special problem in cross-country movement for the earth scientist is the determination of the suitability of areas and types of ground for movement of men on foot or, more commonly, of vehicles equipped with wheels or treads. The basic scientific problem is the determination of significant interrelationships between the elements of terrain that influence movement. The evaluation of the influence is the link between the scientific and applied problems.

For successful attack on the problem of terrain evaluation for special purposes, such as those outlined, it has been necessary to reorient the thinking of geologists, soil scientists, botanists, and climatologists from preoccupation with isolated elements of terrain to a constant awareness of the terrain complex. This necessity is apparent in the purpose of the terrain evaluations, which calls for an exploitation of terrain areas, not terrain elements. At the same time, it becomes necessary to cultivate an understanding of the appropriate combination of elements that will define the essential qualities of a region for a specific use. In some cases, it is quite adequate to limit the consideration to two elements, such as rock and soil, soil and vegetation, soil and climate, or rock and terrain form; but commonly at least three or four elements must be appraised in combination. It has been found also that the significance of any one factor of terrain is commonly a variable. For instance, the significance of slope is not proportional to its steepness. In certain uses of terrain, such as off-road movement of tanks, there is a limit beyond which steepness becomes critical, regardless of other terrain characteristics, but below that limit its significance may be entirely dependent on one or more concomitant features. Thus, a steepness of 30 percent would be highly, or possibly completely, restrictive to movement of tanks, if the soils afford poor traction and large trees require sharp turning. On the other hand, an equivalent steepness would not be a serious obstacle where the soil traction is good and trees are lacking.

A second major problem in making special-purpose terrain evaluations is to find the most effective way to present the results. A familiar graphic approach consists in plotting areal data for each terrain element under consideration on separate transparent sheets. To obtain a composite picture, all the sheets can be superimposed and all boundaries that show through can be traced on a single sheet. By this means, it is hoped to delineate on one map all areas with unique combinations of the different terrain elements considered in the evaluation. The result tends to become complex in appearance and to obscure distinctions between boundaries of primary and subsidiary importance.

To overcome these shortcomings, many ingenious cartographic solutions have been attempted. The most sophisticated solutions are generally too difficult for the nonscientific user. Continual experimentation is going on, therefore, to establish simple formats that translate scientific concepts into terms that will permit the user to read directly qualities of terrain for a designated purpose. It is found, however, that greatest reliability is attributed by the nonscientific user to maps that show the scientific bases of interpretation, but in an unobtrusive manner, so that, if desired, an insight can be gained into the contributing factors. From a scientific viewpoint, this attitude is desirable. It gives the map increased flexibility of use and permits reinterpretation of basic data to accommodate certain changes in the conditions of terrain use without a return to original sources. The research is being conducted by trials with a map of a selected area using the same data in each trial and by applying the same principles to maps of different areas and scales.

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Geological Survey Investigations of the Scurry Reef and "Horseshoe Atoll" in Western Texas

One of the most productive oil-bearing structures in North America is a horseshoe-shaped accumulation of limestone buried more than 6000 ft beneath the plains in western Texas. This structure, called the "Horseshoe atoll" because it resembles modern atolls in size, shape, and some lithologic characteristics, is 70 to 90 mi across and in some places more than 1000 ft thick. Its crest contains irregular mounds, basins, and channels; its flanks, which are indented by sinuous reentrants, slope from the crest at angles generally less than 6° and merge into a broad limestone platform on which the atoll is built.

The highest and most continuous part of the Horseshoe atoll is the southeastern part, which underlies Scurry County and is known as the Scurry reef. Oil was discovered in this reef in 1948. Intensive drilling showed that the Scurry reef is the largest oil-producing limestone reservoir in the Western Hemisphere; it is second only to the East Texas field in proved reserves. Prior to March 1954, 35 smaller fields had also been found in the limestone mounds along the crest of the Horseshoe atoll north and west of the Scurry reef.

The Geological Survey began an investigation of the Scurry reef in 1950 in cooperation with the Bureau of Economic Geology of the University of Texas in an effort to determine the age and lithology of the reef, its relationship to the shale that surrounds and overlies it, the genetic significance of the reef, and the probable origin and paths of migration of petroleum in the reef. The objective of this project was to obtain as much scientific information as possible about the nature and origin of this reeflike mass to

aid in recovering the maximum amount of oil from this structure and in exploring for other similar limestone structures. This investigation involved the study of cores, samples, electric logs, and radioactivity logs made available by the oil industry from several thousand wells drilled into the Scurry reef and adjacent parts of the Horseshoe atoll, and it also included the comparison of Foraminifera obtained in cores from the reef with Foraminifera from outcropping rocks of the same age in central Texas. A special study of the reservoirs in the Scurry reef was made in 1951–52 for the Petroleum Adminstration for Defense to provide that agency with information on the availability of oil and gas from the Scurry fields and to assist in exploration, development, and operation.

The Geological Survey investigations of the Horseshoe atoll showed that this structure was a topographically prominent accumulation of fossiliferous limestone on the floor of the Midland basin in western Texas during late Pennsylvanian and early Permian time. Growth of the atoll and the development of porous zones within it were apparently cyclical and were probably related to periodic changes of sea level. Recent studies indicate that the atoll was smothered during early Permian time by mud and silt that entered the Midland basin from the northeast, terminating the growth of the northeastern side of the atoll before growth ended on the southwestern side.

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Serpentine Pipes at Garnet Ridge, Arizona

Garnet Ridge, about 35 mi northeast of Kayenta, Ariz., earned its name from pyrope garnet that occurs in serpentine pipes underlying the ridge. In addition to serpentine, the pipes are choked with rocks derived from a section more than 5000 ft thick and ranging in age from pre-Cambrian to Cretaceous. Garnet Ridge is a low, oval butte, about 3 by 8 mi in size, composed largely of rocks of the San Rafael group (Jurassic) and capped by rocks of the lower part of the Morrison formation. It rests on the southeast-dipping flank of the Comb monocline and is perforated by the pipes where the monocline rises steeply.

There are four pipes; one is at the Ridge crest and is about 1000 ft across; the other three are 2 mi northeast along the strike and make a cluster 1500 by 4000 ft. Material like that in the pipes also occurs a few miles north along Comb monocline at Moses Rock and Mule Ear in Utah. The pipes at Garnet Ridge are irregular in outline and have nearly vertical walls that locally parallel joint sets in the country rock; the cluster of three pipes is elongate parallel to a northwest-trending set of joints. Country rocks around the pipe cluster are downwarped in a syncline about 2 mi long having 160 ft of closure. Deformation at pipe walls has been by fracturing.

The pipes are filled with two kinds of material: (i) large blocks of sedimentary rocks derived from above, and (ii) pulverized serpentine rubble containing pebble and boulder xenoliths of Paleozoic sedimentary rocks and older crystalline rocks derived from below.

The blocks of sedimentary rocks fell from higher positions into the pipes, and some of Late Cretaceous age demonstrate that 1200 ft or more of rocks covered the area when the pipes were formed. Many of the collapsed blocks exceed 100 ft in size; one piece of massive sandstone, several hundred feet below its former position, is 800 ft long. All are angular. Pieces originally far apart stratigraphically are juxtaposed.

The serpentine rubble is squeezed between the collapsed blocks and along joints in the country rock. It contains xenoliths from more than 4000 ft below. The matrix of the rubble is pale grayish green, pulverized serpentine (var. antigorite) containing much calcite and chlorite. Lesser amounts of olivine, chrome-diopside, biotite, hornblende, gypsum, quartz, pyrope garnet, magnetite, and a reddish clay (shown by x-ray analysis to be montmorillonite) are also present. All gradations of magnesian silicates altering the serpentine can be seen in thin section. Mineralogically, this material is similar to the chloritized-calcitized-serpentinized peridotite bodies known in Kansas, Illinois, Virginia, and New York. The pebble and boulder xenoliths in the rubble are not visibly altered; fossiliferous limestones show no recrystallization; red sandstones and black shales are unbleached. Wall rock in contact with the serpentine rubble is altered in a few places, but the alteration was weak and not necessarily contemporaneous with rubble eruption.

Surficial deposits of serpentine rubble, identical in composition to the intrusive rubble, cap a row of knobs that extends half a mile eastward from the pipe at the crest of Garnet Ridge. Lack of feeder dikes under the knobs and the occurrence of slump blocks at the base of the rubble argue against intrusive emplacement. The surficial deposits are large, compared with the amount of rubble in the pipe, and were probably derived from rubble erupting from the pipe. But the field relationships do not entirely disprove the possibility that the surficial rubble was redeposited without eruptions. The knobs are interpreted as the trace of a former valley into which rubble flowed from the pipe. Subsequent erosion, chiefly sedimentation, has lowered the land surface leaving the surficial rubble perched on the knobs. Resistant constituents derived from the rubble, including garnet, are widespread on the erosion surface.

Because the serpentine rubble appears to be associated with pipe formation, which certainly antedates the surficial deposits, two times of serpentine rubble eruption are suggested—the first Tertiary, the second Pleistocene.

Harold E. Malde

U.S. Geological Survey
Denver Federal Center
Denver, Colorado

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Meetings & Conferences

May

17–19. Radiation Research Soc., annual, Cleveland, Ohio. (A. Edelmann, Brookhaven National Laboratory, Upton, L.I., N.Y.)

24–26. National Telemetering Conf., Chicago, Ill. (W. J. Mayo-Wells, Applied Physics Laboratory, Silver Spring, Md.)

24–27. Symposium on Instrumentation for Industrial Hygiene, Ann Arbor, Mich. (Director, Continued Education, School of Public Health, Univ. of Michigan, Ann Arbor.)

24–28. American Assoc. of Cereal Chemists, annual, Denver, Colo. (C. L. Brooke, Merck & Co., Rahway, N.J.)

June

1–2. International Neurologic Reunion, 19th, Paris, France. (J. Sigwald, 68, Boulevard de Courcelles, Paris 17.)

4–5. American Psychopathological Assoc., New York City. (J. Zubin, 722 W. 168 St., New York 32.)

6–11. Conf. on Industrial Research, Harriman, N.Y. (R. T. Livingston, 409 Engineering Bldg., Columbia Univ., New York 27.)

7–10. National Plastics Exposition and Technical Conf., Cleveland, Ohio. (Soc. of Plastics Industry, 295 Madison Ave., New York 17.)

7–12. International Cong. of Psychology, 14th, Montreal, Can. (H. S. Langfeld, Eno Hall, Princeton Univ., Princeton, N.J.)

7–14. Cold Spring Harbor Symposium on Quantitative Biology, 19th, Cold Spring Harbor, L.I., N.Y. (The Biological Laboratory, Cold Spring Harbor.)

8–10. National Soc. of Professional Engineers, annual, Milwaukee, Wis. (P. H. Robbins, 1121 15 St. NW, Washington 5, D.C.)

9–12. American Soc. for Quality Control, 8th, St. Louis, Mo. (D. Shainin, 70 E. 45 St., New York.)

11–17. Pan American Assoc. of Ophthalmology, 3rd, São Paulo, Brazil. (M. E. Alvaro, Consolacao 1151, São Paulo.)

14–16. American Neurologic Assoc., 79th annual, Atlantic City, N.J. (H. H. Merritt, 710 W. 168 St., New York 32.)

14–16. American Soc. of Agronomy, Corn Belt Branch, annual, Lincoln, Neb. (E. J. Frolik, Dept. of Agronomy, Univ. of Nebraska, Lincoln 3.)

14–18. American Soc. for Engineering Education, annual, Urbana, Ill. (A. B. Bronwell, Northwestern Univ., Evanston, Ill.)

14–18. American Soc. for Testing Materials, annual, Chicago, Ill. (R. J. Painter, 1916 Race St., Philadelphia 3, Pa.)

14–18. Symposium on Molecular Structure and Spectroscopy, annual, Columbus, Ohio. (H. H. Nielsen, Dept. of Physics, Ohio State Univ., Columbus 10.)

14–19. American Soc. of Civil Engineers, Atlantic City, N.J. (D. P. Reynolds, 33 W. 39 St., New York 18.)

14–19. Cong. and Exhibition of l'Aluminium Français and La Société Chimique de France, Paris, France. (R. Gadeau, 23 Rue Balzac, Paris 8.)

15–18. Medical Library Assoc., Washington, D.C. (Col. F. B. Rogers, Armed Forces Medical Library, Washington 25.)

(See the April 16th issue for summer meeting lists.)

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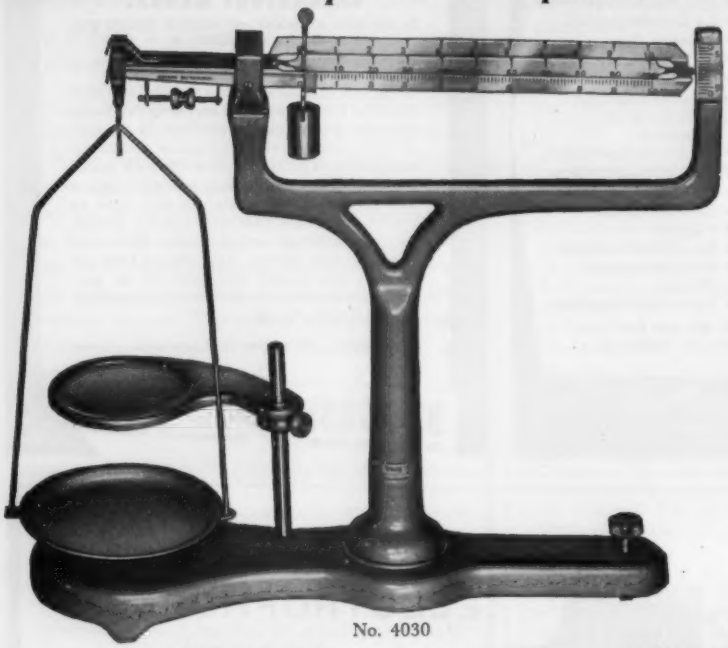

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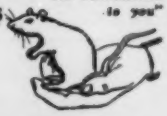

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TRAVEL ARRANGEMENTS FOR THE AAAS BERKELEY MEETING

December 26-31, 1954

In time or in cost, a trip from an eastern city to California is not much more than a **round trip** to a midwestern city. Californians who for years have been attending meetings in the East have told their colleagues that the continental distance is the **same** each way, and that it should be the turn of the Easterners to visit the Pacific Coast.

The Association is planning ways it may assist those who will attend the 121st AAAS Meeting on the campus of the University of California at Berkeley, this December. The possibilities include:

1. Low cost AAAS limousines from Oakland and San Francisco airports and railroad terminals direct to the dormitory or hotel of each delegate.
2. Arrangements for traveling together in AAAS cars on fast trains leaving Chicago, Washington, D. C., and New York.
3. Arrangements for chartering first class DC6, 6B, or 7 planes of scheduled airlines—at prices comparable with air coach travel.

Note: In the following table of **round-trip** fares all figures include the new lowered 10% federal tax.

ROUND TRIPS TO OAKLAND OR SAN FRANCISCO FROM

	Chicago	Washington, D. C.	New York
By Bus	Time: 2½ days $82.50	Time: 4 days $104.94	Time: 4 days $112.31
By Rail	Time: 2½ days — leaving evening, Dec. 24 and morning, Dec. 31	Time: 3½ days — leaving evening, Dec. 23 and morning Dec. 31	Time: 3½ days — leaving evening, Dec. 23 and morning Dec. 31
Reclining seat coach	$ 99.17	$147.62	$156.64
First class	$139.10	$204.33	$222.67
Lower berth	46.20	60.06	63.58
Total	$185.30	$264.39	$286.25
By Air	Time: 7–8 hrs., leaving a.m. or p.m., Dec. 26; returning a.m. or p.m. Dec. 31	Time: 10–11 hrs., leaving a.m. or p.m., Dec. 26; returning a.m. or p.m., Dec. 31	Time: 10–11 hrs., leaving a.m. or p.m., Dec. 26; returning a.m. or p.m., Dec. 31
Air coach (no meals)	$167.20	$215.60	$217.80
Chartered 1st class (meals included)	c. $178.00	c. $235.00	c. $235.00
First class (meals included)	$239.91	$312.18	$332.09

PLEASE READ ABOVE TABLE, FILL OUT THIS COUPON, AND SEND IT TO

AAAS TRAVEL — Dr. R. L. Taylor
1515 Massachusetts Avenue, N.W.
Washington 5, D. C.

Name .....

Address .....

I shall probably attend the AAAS Meeting in Berkeley. Without obligation I am interested in possible group travel arrangements to San Francisco from:

1. ☐ Chicago ☐ Washington, D. C. ☐ New York ☐ Other city: .....
2. My preferred manner of transport is:
   ☐ Rail — coach ☐ Air — coach ☐ Bus
   ☐ Rail — 1st class ☐ Air — chartered, 1st class ☐ Other
   ☐ Air — 1st class
3. I would
   ☐ return east immediately after the meeting
   ☐ like to make a side trip to .....
   ☐ remain indefinitely on the Pacific Coast